Appendix F.3

Air Quality

MOVES Sample Input/Output

MOVES Inputs

MOVES Run Summary

Vehicle Types	Time			Location	Road Type
Gasoline Passenger Vehicle Diesel Combination Short Haul Truck	2016	Weekdays	January & July	Virgian Islands - St. Thomas	Rural Unrestricted Access

Fuel Supply

CountyID	FuelYearID	MonthGroupID	FuelFormulationID	MarketShare	MarketShareCV
78030	2012	1	9172	1	0.5
78030	2012	7	9190	1	0.5
78030	2012	1	20011	1	0.5
78030	2012	7	20011	1	0.5

Hour VMT Fraction

SourceTypeID	RoadTypeID	DayID	HourID	HourVMTFraction
21	3	2	1	0.016421
21	3	2	2	0.011192
21	3	2	3	0.008542
21	3	2	4	0.006793
21	3	2	5	0.007219
21	3	2	6	0.010762
21	3	2	7	0.01768
21	3	2	8	0.026875
21	3	2	9	0.038659
21	3	2	10	0.052239
21	3	2	11	0.063174
21	3	2	12	0.069944

21	3	2	13	0.072933
21	3	2	14	0.073122
21	3	2	15	0.073616
21	3	2	16	0.074461
21	3	2	17	0.074217
21	3	2	18	0.070009
21	3	2	19	0.061404
21	3	2	20	0.050504
21	3	2	21	0.041207
21	3	2	22	0.033637
21	3	2	23	0.026224
21	3	2	24	0.019167
61	3	2	1	0.016421
61	3	2	2	0.011192
61	3	2	3	0.008542
61	3	2	4	0.006793
61	3	2	5	0.007219
61	3	2	6	0.010762
61	3	2	7	0.01768
61	3	2	8	0.026875
61	3	2	9	0.038659
61	3	2	10	0.052239
61	3	2	11	0.063174
61	3	2	12	0.069944
61	3	2	13	0.072933
61	3	2	14	0.073122
61	3	2	15	0.073616
61	3	2	16	0.074461
61	3	2	17	0.074217
61	3	2	18	0.070009

61	3	2	19	0.061404
61	3	2	20	0.050504
61	3	2	21	0.041207
61	3	2	22	0.033637
61	3	2	23	0.026224
61	3	2	24	0.019167

Road Type Distribution

SourceTypeID	RoadTypeID	RoadTypeVMTFraction
21	1	0
21	2	0.083421
21	3	0.289053
21	4	0.209684
21	5	0.417842
61	1	0
61	2	0.324692
61	3	0.294068
61	4	0.207526
61	5	0.173714

Source Type Age Distribution

SourceTypeID	YearID	AgeID	AgeFraction
21	1999	0	0.0646
21	1999	1	0.0602
21	1999	2	0.061
21	1999	3	0.0624
21	1999	4	0.0626
21	1999	5	0.0642
21	1999	6	0.0597
21	1999	7	0.0562
21	1999	8	0.0543
21	1999	9	0.0596
21	1999	10	0.0608
21	1999	11	0.0622
21	1999	12	0.0549
21	1999	13	0.0522
21	1999	14	0.0419
21	1999	15	0.032
21	1999	16	0.0226
21	1999	17	0.0155
21	1999	18	0.0129
21	1999	19	0.0105
21	1999	20	0.008
21	1999	21	0.006
21	1999	22	0.0045
21	1999	23	0.0034
21	1999	24	0.0026
21	1999	25	0.0019
21	1999	26	0.0014

21	1999	27	0.0008
21	1999	28	0.0006
21	1999	29	0.0005
21	1999	30	0
61	1999	0	0.084252
61	1999	1	0.067209
61	1999	2	0.057562
61	1999	3	0.050629
61	1999	4	0.0693
61	1999	5	0.056228
61	1999	6	0.048773
61	1999	7	0.037878
61	1999	8	0.045255
61	1999	9	0.053548
61	1999	10	0.056029
61	1999	11	0.054994
61	1999	12	0.059676
61	1999	13	0.05284
61	1999	14	0.048713
61	1999	15	0.040034
61	1999	16	0.016687
61	1999	17	0.014696
61	1999	18	0.013335
61	1999	19	0.017959
61	1999	20	0.011167
61	1999	21	0.00904
61	1999	22	0.009914
61	1999	23	0.003839
61	1999	24	0.004789
61	1999	25	0.004765

61	1999	26	0.004
61	1999	27	0.003639
61	1999	28	0.002622
61	1999	29	0.000628
61	1999	30	0

Zone Month Hour

MonthID	ZoneID	HourID	Temperature	RelHumidity
1	780300	1	73.7	81.8
7	780300	1	79.5	81.7
1	780300	2	73	82.9
7	780300	2	79	82.2
1	780300	3	72.6	83.5
7	780300	3	78.3	83.3
1	780300	4	72	84.3
7	780300	4	77.7	83.8
1	780300	5	71.6	84.6
7	780300	5	77.4	84
1	780300	6	71.3	84.8
7	780300	6	77	84.9
1	780300	7	70.9	85.4
7	780300	7	76.7	84.9
1	780300	8	70.9	85.4
7	780300	8	78.6	82.4
1	780300	9	73.1	82.6
7	780300	9	82.1	77.6
1	780300	10	78.1	75.4
7	780300	10	85.1	72.4
1	780300	11	81.1	71
7	780300	11	87	69.3
1	780300	12	82.7	67.4
7	780300	12	88.5	67.8
1	780300	13	83.7	65.7
7	780300	13	89.2	66.6
1	780300	14	84.4	64.5

7	780300	14	89.5	66.4
1	780300	15	84.3	64.9
7	780300	15	89.4	66.8
1	780300	16	83.7	65.5
7	780300	16	88.8	67.6
1	780300	17	83	66.1
7	780300	17	87.9	68.4
1	780300	18	81.2	68.6
7	780300	18	86.7	69.9
1	780300	19	78.8	72.5
7	780300	19	85	72.6
1	780300	20	76.9	76.1
7	780300	20	82.8	76.1
1	780300	21	76.2	77.4
7	780300	21	81.5	78.1
1	780300	22	75.5	78.6
7	780300	22	80.9	79.1
1	780300	23	74.9	79.7
7	780300	23	80.5	80.1
1	780300	24	74.4	80.5
7	780300	24	79.9	81.4

MOVES Output

MOVESScenarioID	MOVESRunID	yearID	monthID	dayID	hourID	linkID	pollutantID	processID	sourceTypeID	SCC	fuelTypeID	modelYearID	roadTypeID	avgSpeedBinID	temperature	relHumidity	ratePerDistance
Guam_EF_AllPop	1	2016	1	5	1	780300302	3	1	21		1	0	3	2	73.7	81.8	0.324642
Guam_EF_AllPop	1	2016	1	5	1	780300302	3	15	21		1	0	3	2	73.7	81.8	6.49284E-06
Guam_EF_AllPop	1	2016	1	5	2	780300302	3	1	21		1	0	3	2	73	82.9	0.314503
Guam_EF_AllPop	1	2016	1	5	2	780300302	3	15	21		1	0	3	2	73	82.9	6.29006E-06
Guam_EF_AllPop	1	2016	1	5	3	780300302	3	1	21		1	0	3	2	72.6	83.5	0.308652
Guam_EF_AllPop	1	2016	1	5	3	780300302	3	15	21		1	0	3	2	72.6	83.5	6.17306E-06
Guam_EF_AllPop	1	2016	1	5	4	780300302	3	1	21		1	0	3	2	72	84.3	0.299878
Guam_EF_AllPop	1	2016	1	5	4	780300302	3	15	21		1	0	3	2	72	84.3	5.99757E-06
Guam_EF_AllPop	1	2016	1	5	5	780300302	3	1	21		1	0	3	2	71.6	84.6	0.294259
Guam_EF_AllPop	1	2016	1	5	5	780300302	3	15	21		1	0	3	2	71.6	84.6	5.88517E-06
Guam_EF_AllPop	1	2016	1	5	6	780300302	3	1	21		1	0	3	2	71.3	84.8	0.290003
Guam_EF_AllPop	1	2016	1	5	6	780300302	3	15	21		1	0	3	2	71.3	84.8	5.80007E-06
Guam_EF_AllPop	1	2016	1	5	7	780300302	3	1	21		1	0	3	2	70.9	85.4	0.283777
Guam_EF_AllPop	1	2016	1	5	7	780300302	3	15	21		1	0	3	2	70.9	85.4	5.67554E-06
Guam_EF_AllPop	1	2016	1	5	8	780300302	3	1	21		1	0	3	2	70.9	85.4	0.283777
Guam_EF_AllPop	1	2016	1	5	8	780300302	3	15	21		1	0	3	2	70.9	85.4	5.67553E-06
Guam_EF_AllPop	1	2016	1	5	9	780300302	3	1	21		1	0	3	2	73.1	82.6	0.316202
Guam_EF_AllPop	1	2016	1	5	9	780300302	3	15	21		1	0	3	2	73.1	82.6	6.32404E-06
Guam_EF_AllPop	1	2016	1	5	10	780300302	3	1	21		1	0	3	2	78.1	75.4	0.41452
Guam_EF_AllPop	1	2016	1	5	10	780300302	3	15	21		1	0	3	2	78.1	75.4	8.29042E-06
Guam_EF_AllPop	1	2016	1	5	11	780300302	3	1	21		1	0	3	2	81.1	71	0.467609
Guam_EF_AllPop	1	2016	1	5	11	780300302	3	15	21		1	0	3	2	81.1	71	9.35221E-06
Guam_EF_AllPop	1	2016	1	5	12	780300302	3	1	21		1	0	3	2	82.7	67.4	0.494102
Guam_EF_AllPop	1	2016	1	5	12	780300302	3	15	21		1	0	3	2	82.7	67.4	9.88205E-06
Guam_EF_AllPop	1	2016	1	5	13	780300302	3	1	21		1	0	3	2	83.7	65.7	0.509014
Guam_EF_AllPop	1	2016	1	5	13	780300302	3	15	21		1	0	3	2	83.7	65.7	1.01803E-05
Guam_EF_AllPop	1	2016	1	5	14	780300302	3	1	21		1	0	3	2	84.4	64.5	0.519041

Guam_EF_AllPop	1	2016	1	5	14	780300302	3	15	21		1	0	3	2	84.4	64.5	1.03808E-05
Guam_EF_AllPop	1	2016	1	5	15	780300302	3	1	21		1	0	3	2	84.3	64.9	0.517462
Guam_EF_AllPop	1	2016	1	5	15	780300302	3	15	21		1	0	3	2	84.3	64.9	1.03493E-05
Guam_EF_AllPop	1	2016	1	5	16	780300302	3	1	21		1	0	3	2	83.7	65.5	0.509167
Guam_EF_AllPop	1	2016	1	5	16	780300302	3	15	21		1	0	3	2	83.7	65.5	1.01834E-05
Guam_EF_AllPop	1	2016	1	5	17	780300302	3	1	21		1	0	3	2	83	66.1	0.499314
Guam_EF_AllPop	1	2016	1	5	17	780300302	3	15	21		1	0	3	2	83	66.1	9.98627E-06
Guam_EF_AllPop	1	2016	1	5	18	780300302	3	1	21		1	0	3	2	81.2	68.6	0.471862
Guam_EF_AllPop	1	2016	1	5	18	780300302	3	15	21		1	0	3	2	81.2	68.6	9.43725E-06
Guam_EF_AllPop	1	2016	1	5	19	780300302	3	1	21		1	0	3	2	78.8	72.5	0.431142
Guam_EF_AllPop	1	2016	1	5	19	780300302	3	15	21		1	0	3	2	78.8	72.5	8.62282E-06
Guam_EF_AllPop	1	2016	1	5	20	780300302	3	1	21		1	0	3	2	76.9	76.1	0.369763
Guam_EF_AllPop	1	2016	1	5	20	780300302	3	15	21		1	0	3	2	76.9	76.1	7.39527E-06
Guam_EF_AllPop	1	2016	1	5	21	780300302	3	1	21		1	0	3	2	76.2	77.4	0.360086
Guam_EF_AllPop	1	2016	1	5	21	780300302	3	15	21		1	0	3	2	76.2	77.4	7.20174E-06
Guam_EF_AllPop	1	2016	1	5	22	780300302	3	1	21		1	0	3	2	75.5	78.6	0.350461
Guam_EF_AllPop	1	2016	1	5	22	780300302	3	15	21		1	0	3	2	75.5	78.6	7.00919E-06
Guam_EF_AllPop	1	2016	1	5	23	780300302	3	1	21		1	0	3	2	74.9	79.7	0.341924
Guam_EF_AllPop	1	2016	1	5	23	780300302	3	15	21		1	0	3	2	74.9	79.7	6.83847E-06
Guam_EF_AllPop	1	2016	1	5	24	780300302	3	1	21		1	0	3	2	74.4	80.5	0.334931
Guam_EF_AllPop	1	2016	1	5	24	780300302	3	15	21		1	0	3	2	74.4	80.5	6.69863E-06

Construction Emissions Estimate

Guam Construction Emissions

Total Construction Equipment Emissions – Training

Equipment Training																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																				
Asphalt paver, 130 HP	1	2	16	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.00	0.00	0.00	0.00	0.01	0.00	0.72
Backhoe loader, 48hp	1	44	352	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.00	0.02	0.00	0.00	0.02	0.01	2.70
Chain saws, 36"	1	180	1440	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	2.64	0.07	0.07	0.01	0.53	5.19
Chipping machine	1	90	720	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.01	0.12	0.02	0.02	0.29	0.03	27.01
Compressor, 250 cfm	1	63	504	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.00	0.06	0.01	0.01	0.09	0.01	12.67
Concrete pump, small	1	21	168	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.00	0.01	0.00	0.00	0.03	0.00	2.38
Crane, 90-tons	1	2	16	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.00	0.00	0.00	0.01	0.00	0.90
Crane, Hydraulic, 33 tons	1	626	5008	315	43	0.11	1.55	0.25	0.25	5.59	0.34	530.50	0.09	1.16	0.19	0.18	4.18	0.26	396.32
Crane, SP, 12 ton	1	36	288	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.02	0.01	0.00	0.11	0.01	12.66
Crane, SP, 5 ton	1	34	272	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.02	0.00	0.00	0.11	0.01	11.96
Crane, 40 ton	1	8	64	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.00	0.01	0.00	0.00	0.04	0.00	4.53
Dozer, 200 HP	1	801	6408	200	59	0.12	1.29	0.26	0.25	4.16	0.32	536.38	0.10	1.07	0.22	0.21	3.46	0.26	446.67
Dozer, 300 HP	1	3	24	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.00	0.01	0.00	0.00	0.02	0.00	2.52
Front end loader, 1.5 cy	1	3	24	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.00	0.01	0.00	0.00	0.02	0.00	2.04
Front end loader, TM, 2.5cy	1	90	720	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.01	0.24	0.04	0.04	0.57	0.04	61.21
FE attachment, 3cy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas engine vibrator	1	42	336	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	0.10	0.00	0.00	0.00	0.02	0.35
Gas welding machine	1	16	128	66	68	0.01	38.49	0.06	0.06	7.26	2.02	615.82	0.00	0.24	0.00	0.00	0.05	0.01	3.90
Gradall, 3 ton, 1/2 cy	1	3	24	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.00	0.00	0.00	0.00	0.01	0.00	1.05
Grader, 30000 lb	1	176	1408	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.02	0.27	0.05	0.05	0.80	0.06	100.48
Pneumatic wheel roller	1	2	16	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58
Vibratory roller	1	3	24	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.00	0.00	0.00	0.01	0.00	0.80
Rollers, steel wheel	1	4	32	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.00	0.00	0.00	0.01	0.00	1.07
Total Emissions													0.24	6.02	0.63	0.61	9.83	1.25	1097.74

Total Construction Equipment Emissions – Alternative A

Equipment Alternative A																			
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)						
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	585	4680	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.05	0.63	0.13	0.13	1.80	0.15	211.98
Backhoe loader, 48hp	1	1707	13656	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.02	0.94	0.15	0.15	0.87	0.23	104.94
Centrifugal water pump, 6"	1	22	176	57	43	0.18	2.37	0.24	0.23	4.70	0.37	567.00	0.00	0.01	0.00	0.00	0.02	0.00	2.69
Chain saws, 36"	1	830	6640	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	12.17	0.34	0.31	0.03	2.44	23.94
Chipping machine	1	415	3320	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.03	0.56	0.10	0.10	1.35	0.13	124.57
Compressor, 250 cfm	1	11936	95488	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.52	10.70	1.56	1.51	16.33	1.32	2400.92
Concrete pump, small	1	1673	13384	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.04	1.01	0.19	0.19	2.06	0.25	189.57
Crane, 90-tons	1	889	7112	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.09	0.71	0.16	0.15	3.55	0.25	402.05
Crane, SP, 12 ton	1	3050	24400	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.23	1.91	0.43	0.41	9.48	0.67	1072.83
Crane, SP, 5 ton	1	2206	17648	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.17	1.38	0.31	0.30	6.86	0.48	775.95
Crane, 40 ton	1	226	1808	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.03	0.23	0.05	0.05	1.13	0.08	128.10
Drill rig & augers	1	114	912	176	43	0.16	0.87	0.18	0.17	4.10	0.34	539.00	0.01	0.07	0.01	0.01	0.31	0.03	40.88
Dozer, 300 HP	1	660	5280	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.12	1.99	0.30	0.30	4.86	0.34	555.12
Front end loader, 1.5 cy	1	660	5280	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.10	1.74	0.27	0.27	4.20	0.30	448.90
Front end loader, TM, 2.5cy	1	415	3320	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.06	1.10	0.17	0.17	2.64	0.19	282.26
Gas engine vibrator	1	2487	19896	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	5.80	0.15	0.14	0.03	1.13	20.93
Gas welding machine	1	2327	18616	66	68	0.01	38.49	0.06	0.06	7.26	2.02	615.82	0.01	35.41	0.05	0.05	6.68	1.86	566.64
Gradall, 3 ton, 1/2 cy	1	634	5072	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.05	0.59	0.13	0.12	1.53	0.13	220.96
Grader, 30000 lb	1	1926	15408	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.24	2.97	0.57	0.55	8.72	0.65	1099.54
Hydraulic excavator, 3.5 cy	1	1	8	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.00	0.00	0.00	0.00	0.00	0.00	0.48
Pneumatic wheel roller	1	585	4680	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.05	0.71	0.07	0.07	1.41	0.11	168.29
Vibratory roller	1	660	5280	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.04	0.79	0.13	0.13	1.51	0.13	176.94
Rollers, steel wheel	1	1170	9360	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.07	1.40	0.23	0.22	2.68	0.24	313.67
Total Emissions													1.92	82.81	5.51	5.33	78.07	11.12	9332.14

Total Construction Equipment Emissions – Alternative B

Equipment Alternative B (Total)																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	581	4648	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.05	0.63	0.13	0.13	1.78	0.15	210.53
Backhoe loader, 48hp	1	1694	13552	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.02	0.93	0.15	0.15	0.87	0.22	104.14
Centrifugal water pump, 6"	1	22	176	57	43	0.18	2.37	0.24	0.23	4.70	0.37	567.00	0.00	0.01	0.00	0.00	0.02	0.00	2.69
Chain saws, 36"	1	826	6608	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	12.11	0.34	0.31	0.03	2.43	23.82
Chipping machine	1	413	3304	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.03	0.55	0.10	0.10	1.35	0.13	123.97
Compressor, 250 cfm	1	11936	95488	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.52	10.70	1.56	1.51	16.33	1.32	2400.92
Concrete pump, small	1	1673	13384	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.04	1.01	0.19	0.19	2.06	0.25	189.57
Crane, 90-tons	1	890	7120	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.09	0.72	0.16	0.15	3.56	0.25	402.50
Crane, SP, 12 ton	1	3108	24864	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.24	1.94	0.43	0.42	9.66	0.68	1093.23
Crane, SP, 5 ton	1	2195	17560	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.17	1.37	0.31	0.30	6.83	0.48	772.08
Crane, 40 ton	1	226	1808	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.03	0.23	0.05	0.05	1.13	0.08	128.10
Drill rig & augers	1	114	912	176	43	0.16	0.87	0.18	0.17	4.10	0.34	539.00	0.01	0.07	0.01	0.01	0.31	0.03	40.88
Dozer, 300 HP	1	656	5248	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.12	1.97	0.30	0.29	4.83	0.33	551.75
Front end loader, 1.5 cy	1	656	5248	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.10	1.73	0.27	0.26	4.17	0.30	446.18
Front end loader, TM, 2.5cy	1	413	3304	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.06	1.09	0.17	0.17	2.63	0.19	280.90
Gas engine vibrator	1	2487	19896	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	5.80	0.15	0.14	0.03	1.13	20.93
Gas welding machine	1	2328	18624	66	68	0.01	38.49	0.06	0.06	7.26	2.02	615.82	0.01	35.43	0.05	0.05	6.68	1.86	566.89
Gradall, 3 ton, 1/2 cy	1	630	5040	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.05	0.58	0.13	0.12	1.52	0.13	219.56
Grader, 30000 lb	1	1914	15312	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.24	2.96	0.57	0.55	8.66	0.65	1092.69
Hydraulic excavator, 3.5 cy	1	126	1008	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.01	0.18	0.03	0.03	0.48	0.04	60.65
Pneumatic wheel roller	1	581	4648	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.05	0.71	0.07	0.07	1.41	0.11	167.14
Vibratory roller	1	656	5248	92.3	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.04	0.78	0.13	0.13	1.50	0.13	175.87
Rollers, steel wheel	1	1162	9296	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.07	1.39	0.23	0.22	2.66	0.24	311.52
Total Emissions													1.93	82.90	5.54	5.35	78.50	11.14	9386.51

Total Construction Equipment Emissions – Alternative B (Non Housing)

Equipment Alternative B (NonHousing)																			
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)						
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	529	4232	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.04	0.57	0.12	0.12	1.62	0.13	191.69
Backhoe loader, 48hp	1	1544	12352	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.02	0.85	0.14	0.13	0.79	0.20	94.92
Centrifugal water pump, 6"	1	22	176	57	43	0.18	2.37	0.24	0.23	4.70	0.37	567.00	0.00	0.01	0.00	0.00	0.02	0.00	2.69
Chain saws, 36"	1	744	5952	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	10.91	0.30	0.28	0.03	2.19	21.46
Chipping machine	1	372	2976	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.02	0.50	0.09	0.09	1.21	0.12	111.66
Compressor, 250 cfm	1	7506	60048	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.32	6.73	0.98	0.95	10.27	0.83	1509.83
Concrete pump, small	1	1673	13384	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.04	1.01	0.19	0.19	2.06	0.25	189.57
Crane, 90-tons	1	890	7120	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.09	0.72	0.16	0.15	3.56	0.25	402.50
Crane, SP, 12 ton	1	2840	22720	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.21	1.77	0.40	0.38	8.83	0.62	998.96
Crane, SP, 5 ton	1	2070	16560	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.16	1.29	0.29	0.28	6.44	0.45	728.11
Crane, 40 ton	1	226	1808	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.03	0.23	0.05	0.05	1.13	0.08	128.10
Drill rig & augers	1	114	912	176	43	0.16	0.87	0.18	0.17	4.10	0.34	539.00	0.01	0.07	0.01	0.01	0.31	0.03	40.88
Dozer, 300 HP	1	593	4744	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.11	1.78	0.27	0.27	4.37	0.30	498.76
Front end loader, 1.5 cy	1	593	4744	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.09	1.57	0.25	0.24	3.77	0.27	403.33
Front end loader, TM, 2.5cy	1	372	2976	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.05	0.98	0.15	0.15	2.37	0.17	253.02
Gas engine vibrator	1	2301	18408	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	5.37	0.14	0.13	0.03	1.05	19.37
Gas welding machine	1	2328	18624	66	68	0.01	38.49	0.06	0.06	7.26	2.02	615.82	0.01	35.43	0.05	0.05	6.68	1.86	566.89
Gradall, 3 ton, 1/2 cy	1	574	4592	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.04	0.53	0.11	0.11	1.39	0.12	200.05
Grader, 30000 lb	1	1732	13856	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.21	2.67	0.51	0.50	7.84	0.59	988.79
Hydraulic excavator, 3.5 cy	1	126	1008	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.01	0.18	0.03	0.03	0.48	0.04	60.65
Pneumatic wheel roller	1	529	4232	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.05	0.64	0.07	0.06	1.28	0.10	152.18
Vibratory roller	1	593	4744	92.3	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.03	0.71	0.12	0.11	1.36	0.12	158.98
Rollers, steel wheel	1	1058	8464	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.06	1.26	0.21	0.20	2.42	0.22	283.64
Total Emissions													1.63	75.79	4.65	4.49	68.25	10.00	8006.01

Total Construction Equipment Emissions – Alternative B (Housing)

Equipment Alternative B (Housing)																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	52	416	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.00	0.06	0.01	0.01	0.16	0.01	18.84
Backhoe loader, 48hp	1	151	1208	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.00	0.08	0.01	0.01	0.08	0.02	9.28
Centrifugal water pump, 6"	1	82	656	57	43	0.18	2.37	0.24	0.23	4.70	0.37	567.00	0.00	0.04	0.00	0.00	0.08	0.01	10.04
Chain saws, 36"	1	41	328	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	0.60	0.02	0.02	0.00	0.12	1.18
Compressor, 250 cfm	1	4431	35448	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.19	3.97	0.58	0.56	6.06	0.49	891.29
Crane, SP, 12 ton	1	270	2160	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.02	0.17	0.04	0.04	0.84	0.06	94.97
Crane, SP, 5 ton	1	126	1008	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.01	0.08	0.02	0.02	0.39	0.03	44.32
Dozer, 300 HP	1	63	504	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.01	0.06	0.01	0.01	0.32	0.02	35.71
Front end loader, 1.5 cy	1	63	504	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.01	0.17	0.03	0.03	0.40	0.03	42.85
Front end loader, TM, 2.5cy	1	41	328	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.01	0.11	0.02	0.02	0.26	0.02	27.89
Gas engine vibrator	1	187	1496	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	0.44	0.01	0.01	0.00	0.09	1.57
Gradall, 3 ton, 1/2 cy	1	56	448	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.00	0.05	0.01	0.01	0.14	0.01	19.52
Grader, 30000 lb	1	183	1464	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.02	0.28	0.05	0.05	0.83	0.06	104.47
Pneumatic wheel roller	1	52	416	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.00	0.06	0.01	0.01	0.13	0.01	14.96
Vibratory roller	1	63	504	92.3	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.00	0.08	0.01	0.01	0.14	0.01	16.89
Rollers, steel wheel	1	104	832	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.01	0.12	0.02	0.02	0.24	0.02	27.88
Total Emissions													0.30	6.37	0.85	0.83	10.07	1.01	1361.67

Total Construction Equipment Emissions – Alternative C

Equipment Alternative C																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	584	4672	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.05	0.63	0.13	0.13	1.79	0.15	211.61
Backhoe loader, 48hp	1	1703	13624	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.02	0.94	0.15	0.15	0.87	0.23	104.69
Centrifugal water pump, 6"	1	22	176	57	43	0.18	2.37	0.24	0.23	4.70	0.37	567.00	0.00	0.01	0.00	0.00	0.02	0.00	2.69
Chain saws, 36"	1	772	6176	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	11.32	0.32	0.29	0.03	2.27	22.26
Chipping machine	1	386	3088	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.02	0.52	0.09	0.09	1.26	0.12	115.86
Compressor, 250 cfm	1	11936	95488	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.52	10.70	1.56	1.51	16.33	1.32	2400.92
Concrete pump, small	1	1673	13384	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.04	1.01	0.19	0.19	2.06	0.25	189.57
Crane, 90-tons	1	903	7224	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.09	0.73	0.16	0.16	3.61	0.25	408.38
Crane, SP, 12 ton	1	3045	24360	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.23	1.90	0.42	0.41	9.47	0.67	1071.07
Crane, SP, 5 ton	1	2203	17624	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.17	1.38	0.31	0.30	6.85	0.48	774.90
Crane, 40 ton	1	226	1808	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.03	0.23	0.05	0.05	1.13	0.08	128.10
Drill rig & augers	1	114	912	176	43	0.16	0.87	0.18	0.17	4.10	0.34	539.00	0.01	0.07	0.01	0.01	0.31	0.03	40.88
Dozer, 300 HP	1	659	5272	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.12	1.98	0.30	0.29	4.85	0.34	554.28
Front end loader, 1.5 cy	1	659	5272	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.10	1.74	0.27	0.27	4.19	0.30	448.22
Front end loader, TM, 2.5cy	1	386	3088	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.06	1.02	0.16	0.16	2.46	0.18	262.54
Gas engine vibrator	1	2487	19896	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	5.80	0.15	0.14	0.03	1.13	20.93
Gas welding machine	1	2327	18616	66	68	0.01	38.49	0.06	0.06	7.26	2.02	615.82	0.01	35.41	0.05	0.05	6.68	1.86	566.64
Gradall, 3 ton, 1/2 cy	1	633	5064	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.05	0.59	0.13	0.12	1.53	0.13	220.61
Grader, 30000 lb	1	1869	14952	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.23	2.89	0.55	0.54	8.46	0.63	1067.00
Hydraulic excavator, 3.5 cy	1	1	8	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.00	0.00	0.00	0.00	0.00	0.00	0.48
Pneumatic wheel roller	1	584	4672	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.05	0.71	0.07	0.07	1.41	0.11	168.00
Vibratory roller	1	659	5272	92.3	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.04	0.79	0.13	0.13	1.51	0.13	176.67
Rollers, steel wheel	1	1168	9344	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.07	1.39	0.23	0.22	2.67	0.24	313.13
Total Emissions													1.90	81.75	5.45	5.27	77.53	10.91	9269.44

Total Construction Equipment Emissions – Alternative D

Equipment Alternative D																			
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)						
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Asphalt paver, 130 HP	1	586	4688	130	59	0.12	1.60	0.33	0.32	4.54	0.37	536.21	0.05	0.63	0.13	0.13	1.80	0.15	212.34
Backhoe loader, 48hp	1	1711	13688	48	21	0.15	6.20	1.00	0.97	5.75	1.49	692.19	0.02	0.94	0.15	0.15	0.87	0.23	105.18
Centrifugal water pump, 6"	1	22	176	57	43	0.18	2.37	0.24	0.23	4.70	0.37	567.00	0.00	0.01	0.00	0.00	0.02	0.00	2.69
Chain saws, 36"	1	832	6656	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	12.20	0.34	0.31	0.03	2.45	23.99
Chipping machine	1	416	3328	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.03	0.56	0.10	0.10	1.36	0.13	124.87
Compressor, 250 cfm	1	11936	95488	90	43	0.13	2.63	0.38	0.37	4.01	0.32	589.94	0.52	10.70	1.56	1.51	16.33	1.32	2400.92
Concrete pump, small	1	1673	13384	53	43	0.12	3.03	0.57	0.56	6.18	0.75	567.14	0.04	1.01	0.19	0.19	2.06	0.25	189.57
Crane, 90-tons	1	889	7112	225	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.09	0.71	0.16	0.15	3.55	0.25	402.05
Crane, SP, 12 ton	1	3058	24464	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.23	1.91	0.43	0.41	9.51	0.67	1075.64
Crane, SP, 5 ton	1	2210	17680	175	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.17	1.38	0.31	0.30	6.87	0.48	777.36
Crane, 40 ton	1	226	1808	282	43	0.11	0.94	0.21	0.20	4.69	0.33	530.54	0.03	0.23	0.05	0.05	1.13	0.08	128.10
Drill rig & augers	1	114	912	176	43	0.16	0.87	0.18	0.17	4.10	0.34	539.00	0.01	0.07	0.01	0.01	0.31	0.03	40.88
Dozer, 300 HP	1	661	5288	300	59	0.12	1.93	0.30	0.29	4.72	0.33	539.34	0.12	1.99	0.30	0.30	4.87	0.34	555.96
Front end loader, 1.5 cy	1	661	5288	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.10	1.74	0.27	0.27	4.21	0.30	449.58
Front end loader, TM, 2.5cy	1	416	3328	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.06	1.10	0.17	0.17	2.65	0.19	282.94
Gas engine vibrator	1	2487	19896	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	5.80	0.15	0.14	0.03	1.13	20.93
Gas welding machine	1	2327	18616	66	68	0.01	38.49	0.06	0.06	7.26	2.02	615.82	0.01	35.41	0.05	0.05	6.68	1.86	566.64
Gradall, 3 ton, 1/2 cy	1	636	5088	125	59	0.12	1.42	0.31	0.30	3.71	0.32	536.36	0.05	0.59	0.13	0.12	1.53	0.13	221.66
Grader, 30000 lb	1	1929	15432	204	59	0.12	1.45	0.28	0.27	4.26	0.32	537.25	0.24	2.98	0.57	0.55	8.73	0.65	1101.25
Hydraulic excavator, 3.5 cy	1	1	8	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.00	0.00	0.00	0.00	0.00	0.00	0.48
Pneumatic wheel roller	1	586	4688	99	59	0.18	2.37	0.24	0.23	4.70	0.37	559.00	0.05	0.71	0.07	0.07	1.42	0.11	168.58
Vibratory roller	1	661	5288	92.3	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.04	0.79	0.13	0.13	1.51	0.13	177.21
Rollers, steel wheel	1	1172	9376	92	59	0.12	2.49	0.41	0.40	4.77	0.42	558.97	0.07	1.40	0.23	0.22	2.68	0.24	314.20
Total Emissions													1.92	82.87	5.52	5.33	78.16	11.14	9343.03

Total Construction Equipment Emissions – Alternative IT-S

Equipment Alternative IT-S																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Chain saws, 36"	1	826	6608	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.00	12.11	0.34	0.31	0.03	2.43	23.82
Chipping machine	1	413	3304	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.03	0.55	0.10	0.10	1.35	0.13	123.97
Front end loader, TM, 2.5cy	1	413	3304	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.06	1.09	0.17	0.17	2.63	0.19	280.90
Gas engine vibrator	1	1231	9848	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	2.87	0.08	0.07	0.01	0.56	10.36
Hydraulic excavator, 3.5 cy	1	678	5424	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.07	0.99	0.18	0.17	2.56	0.19	326.34
Total Emissions													0.16	17.62	0.86	0.82	6.58	3.51	765.39

Total Construction Equipment Emissions – Alternative IT-M

Equipment Alternative IT-M																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Chain saws, 36"	1	970	7760	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.01	14.23	0.40	0.37	0.04	2.86	27.97
Chipping machine	1	485	3880	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.03	0.65	0.12	0.11	1.58	0.16	145.58
Front end loader, TM, 2.5cy	1	485	3880	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.07	1.28	0.20	0.20	3.09	0.22	329.87
Gas engine vibrator	1	1448	11584	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	3.38	0.09	0.08	0.02	0.66	12.19
Hydraulic excavator, 3.5 cy	1	797	6376	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.08	1.16	0.21	0.20	3.01	0.23	383.62
Total Emissions													0.19	20.70	1.01	0.96	7.73	4.12	899.23

Total Construction Equipment Emissions – Alternative IT-L

Equipment Alternative IT-L																				
Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)							Emission Rate (tons)							
						SO2	CO	PM10	PM2.5	NOx	VOC	CO_2	SO2	CO	PM10	PM2.5	NOx	VOC	CO_2
Construction Equipment Emissions																			
Chain saws, 36"	1	1116	8928	7	70	0.14	349.18	9.76	8.98	0.91	70.10	686.61	0.01	16.37	0.46	0.42	0.04	3.29	32.18
Chipping machine	1	558	4464	144	43	0.12	2.46	0.45	0.43	5.98	0.59	550.61	0.04	0.75	0.14	0.13	1.82	0.18	167.49
Front end loader, TM, 2.5cy	1	558	4464	243	59	0.12	2.09	0.33	0.32	5.05	0.37	539.44	0.08	1.47	0.23	0.23	3.55	0.26	379.52
Gas engine vibrator	1	1666	13328	2	55	0.22	291.97	7.64	7.03	1.42	57.01	1053.35	0.00	3.89	0.10	0.09	0.02	0.76	14.02
Hydraulic excavator, 3.5 cy	1	917	7336	171	59	0.12	1.64	0.29	0.28	4.25	0.32	541.49	0.09	1.34	0.24	0.23	3.46	0.26	441.38
Total Emissions													0.22	23.81	1.17	1.10	8.89	4.74	1034.60

Total Construction Vehicle Emissions – Training

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	14	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.00	0.00	0.00	0.01	0.00	3.40
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Number of Units	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	4017	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.00	0.17	0.05	0.04	0.51	0.03	228.91
Cars	9906	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.00	0.66	0.01	0.00	0.04	0.02	80.54
Total motor vehicle emissions										0.00	0.83	0.06	0.04	0.56	0.04	312.85

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative A

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	1638	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.44	0.15	0.08	0.98	0.12	397.78
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	127859	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.05	5.29	1.59	1.27	16.12	0.90	7286.18
Cars	562567	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.09	37.48	0.38	0.13	2.33	0.87	4573.71
Total motor vehicle emissions										0.14	43.21	2.12	1.48	19.43	1.88	12257.67

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative B

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	1630	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.44	0.15	0.08	0.98	0.12	395.84
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	128152	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.05	5.30	1.60	1.27	16.16	0.90	7302.87
Cars	563406	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.09	37.53	0.38	0.13	2.33	0.87	4580.54
Total motor vehicle emissions										0.14	43.28	2.13	1.48	19.47	1.88	12279.25

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative B (Non Housing)

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	1504	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.41	0.14	0.07	0.90	0.11	365.24
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	114944	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.05	4.76	1.43	1.14	14.49	0.81	6550.20
Cars	472439	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.07	31.47	0.32	0.11	1.96	0.73	3840.97
Total motor vehicle emissions										0.12	36.64	1.89	1.32	17.35	1.64	10756.41

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative B (Housing)

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	126	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.03	0.01	0.01	0.08	0.01	30.60
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	13228	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	0.55	0.16	0.13	1.67	0.09	753.81
Cars	91011	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.01	6.06	0.06	0.02	0.38	0.14	739.93
Total motor vehicle emissions										0.02	6.64	0.24	0.16	2.12	0.24	1524.34

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative C

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	1636	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.44	0.15	0.08	0.98	0.12	397.29
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	127924	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.05	5.29	1.59	1.27	16.13	0.90	7289.88
Cars	562455	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.09	37.47	0.38	0.13	2.33	0.87	4572.80
Total motor vehicle emissions										0.14	43.21	2.12	1.48	19.44	1.88	12259.98

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative D

On Site Vehicle Emission																
			Emission Factor (lb/hr)							Emissions (tons)						
Type of Vehicle	Days	Hours per Day	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
On Site Vehicle[1]																
Trucks	1640	8	0.00	0.07	0.02	0.01	0.15	0.02	60.71	0.00	0.45	0.15	0.08	0.98	0.12	398.27
Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[2]																
Trucks	127929	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.05	5.29	1.59	1.27	16.13	0.90	7290.17
Cars	562741	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.09	37.49	0.38	0.13	2.33	0.87	4575.13
Total motor vehicle emissions										0.14	43.23	2.12	1.48	19.44	1.88	12263.56

Assumption

1. Onsite vehicles speed: 5 mph
2. Offsite vehicles speed: 30 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day

Total Construction Vehicle Emissions – Alternative IT-S

Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[1]																
Trucks	16331	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	0.68	0.20	0.16	2.06	0.11	930.64
Cars	33036	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.01	2.20	0.02	0.01	0.14	0.05	268.59
Total motor vehicle emissions										0.01	2.88	0.23	0.17	2.20	0.17	1199.22

Assumption

1. Offsite vehicles speed: 30 mph
2. Roadway type: Rural unrestricted
3. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
4. Off site passenger cars are running 20 miles round trip

Total Construction Vehicle Emissions – Alternative IT-M

Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[1]																
Trucks	19209	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	0.79	0.24	0.19	2.42	0.13	1094.64
Cars	38856	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.01	2.59	0.03	0.01	0.16	0.06	315.90
Total motor vehicle emissions										0.01	3.38	0.27	0.20	2.58	0.19	1410.55

Assumption

1. Offsite vehicles speed: 30 mph
2. Roadway type: Rural unrestricted
3. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
4. Off site passenger cars are running 20 miles round trip

Total Construction Vehicle Emissions – Alternative IT-L

Off Site Vehicle Emission																
			Emission Factor (lb/Miles)							Emissions (tons)						
Type of Vehicle	Days	Miles Traveled	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_X	VOC	CO_2
Off Site Vehicle[1]																
Trucks	22099	20	0.00	0.00	0.00	0.00	0.01	0.00	5.70	0.01	0.91	0.28	0.22	2.79	0.15	1259.33
Cars	44698	20	0.00	0.01	0.00	0.00	0.00	0.00	0.81	0.01	2.98	0.03	0.01	0.19	0.07	363.40
Total motor vehicle emissions										0.02	3.89	0.31	0.23	2.97	0.22	1622.73

Assumption

1. Offsite vehicles speed: 30 mph
2. Roadway type: Rural unrestricted
3. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
4. Off site passenger cars are running 20 miles round trip

Annual Construction Emissions – Training

	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Training	0.2	6.8	0.7	0.6	10.4	1.3	1410.6

Annual Construction Emissions – Alternative A

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative A	2017	0.00	0.01	0.56	0.03	0.03	0.43	0.06	96.23
	2018	0.16	0.33	20.11	1.22	1.09	15.56	2.07	3445.43
	2019	0.29	0.60	36.47	2.21	1.97	28.21	3.76	6247.33
	2020	0.08	0.15	9.46	0.57	0.51	7.32	0.98	1621.25
	2021	0.36	0.75	45.85	2.78	2.48	35.48	4.73	7855.15
	2022	0.11	0.22	13.57	0.82	0.73	10.50	1.40	2324.43

Annual Construction Emissions – Alternative B

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative B	2017	0.00	0.01	0.56	0.03	0.03	0.44	0.06	96.57
	2018	0.16	0.33	20.14	1.22	1.09	15.63	2.08	3457.55
	2019	0.29	0.60	36.51	2.22	1.98	28.35	3.77	6269.31
	2020	0.08	0.16	9.48	0.58	0.51	7.36	0.98	1626.95
	2021	0.36	0.75	45.91	2.79	2.48	35.65	4.74	7882.78
	2022	0.11	0.22	13.58	0.83	0.74	10.55	1.40	2332.60

Annual Construction Emissions – Alternative B (Housing)

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative B - Housing	2017	0.00	0.00	0.06	0.00	0.00	0.05	0.01	12.86
	2018	0.16	0.05	2.08	0.17	0.16	1.94	0.20	460.57
	2019	0.29	0.09	3.77	0.32	0.28	3.53	0.36	835.11
	2020	0.08	0.02	0.98	0.08	0.07	0.92	0.09	216.72
	2021	0.36	0.11	4.74	0.40	0.36	4.43	0.46	1050.03
	2022	0.11	0.03	1.40	0.12	0.11	1.31	0.13	310.72

Annual Construction Emissions – Alternative C

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative C	2017	0.00	0.00	0.11	0.01	0.01	0.09	0.01	19.44
	2018	0.07	0.15	9.20	0.56	0.50	7.14	0.94	1585.78
	2019	0.31	0.64	39.12	2.37	2.11	30.36	4.00	6739.58
	2020	0.12	0.25	15.41	0.93	0.83	11.96	1.58	2654.99
	2021	0.24	0.50	30.30	1.84	1.64	23.51	3.10	5219.78
	2022	0.25	0.50	30.82	1.87	1.66	23.92	3.15	5309.85

Annual Construction Emissions – Alternative D

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative D	2017	0.01	0.02	1.33	0.08	0.07	1.03	0.14	228.30
	2018	0.15	0.30	18.63	1.13	1.01	14.42	1.92	3192.90
	2019	0.27	0.57	34.66	2.10	1.87	26.83	3.58	5939.23
	2020	0.09	0.18	11.05	0.67	0.60	8.55	1.14	1893.67
	2021	0.33	0.68	41.41	2.51	2.24	32.06	4.27	7096.14
	2022	0.15	0.31	19.00	1.15	1.03	14.71	1.96	3256.35

Annual Construction Emissions – Alternative IT-S

	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative IT-S	0.1	6.8	0.4	0.3	2.9	1.2	654.9

IT/Comm related emissions are equally distributed to year 2018, 2019 and 2020.

Annual Construction Emissions – Alternative IT-M

	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative IT-M	0.1	8.0	0.4	0.4	3.4	1.4	769.9

IT/Comm related emissions are equally distributed to year 2018, 2019 and 2020.

Annual Construction Emissions – Alternative IT-L

	Pollutant (tpy)						
	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Alternative IT-L	0.1	9.2	0.5	0.4	4.0	1.7	885.8

IT/Comm related emissions are equally distributed to year 2018, 2019 and 2020.

Total Annual Construction Emission - Training, Alternative A and IT

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Training + Alternative A + IT	2017	0.0	0.1	4.0	0.4	0.4	5.6	0.7	801.5
	2018	0.2	0.5	32.8	2.1	1.9	24.7	4.4	5036.5
	2019	0.3	0.7	45.7	2.7	2.4	32.2	5.4	7133.1
	2020	0.1	0.2	18.7	1.1	1.0	11.3	2.6	2507.0
	2021	0.4	0.7	45.9	2.8	2.5	35.5	4.7	7855.1
	2022	0.1	0.2	13.6	0.8	0.7	10.5	1.4	2324.4

Training will take place during first two years of the construction phase. Therefore, training related emissions are only applied to years 2017 and 2018 after distributing them equally.

IT/Comm related emissions are applied to year 2018, 2019 and 2020.

Total Annual Construction Emission - Training, Alternative B and IT

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Training + Alternative B + IT	2017	0.0	0.1	4.0	0.4	0.4	5.6	0.7	801.9
	2018	0.2	0.5	32.8	2.1	1.9	24.8	4.4	5048.6
	2019	0.3	0.7	45.7	2.7	2.4	32.3	5.4	7155.1
	2020	0.1	0.2	18.7	1.1	1.0	11.3	2.6	2512.7
	2021	0.4	0.8	45.9	2.8	2.5	35.6	4.7	7882.8
	2022	0.1	0.2	13.6	0.8	0.7	10.5	1.4	2332.6

Training will take place during first two years of the construction phase. Therefore, training related emissions are only applied to years 2017 and 2018 after distributing them equally.

IT/Comm related emissions are applied to year 2018, 2019 and 2020.

Total Annual Construction Emission - Training, Alternative B – Housing and IT

Training+Alternative B - Housing

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Training + Alternative B - Housing + IT	2017	0.0	0.1	3.5	0.3	0.3	5.2	0.7	718.2
	2018	0.2	0.2	14.7	1.0	0.9	11.1	2.5	2051.6
	2019	0.3	0.2	13.0	0.8	0.7	7.5	2.0	1720.9
	2020	0.1	0.1	10.2	0.6	0.5	4.9	1.7	1102.5
	2021	0.4	0.1	4.7	0.4	0.4	4.4	0.5	1050.0
	2022	0.1	0.0	1.4	0.1	0.1	1.3	0.1	310.7

Training will take place during first two years of the construction phase. Therefore, training related emissions are only applied to years 2017 and 2018 after distributing them equally.

IT/Comm related emissions are applied to year 2018, 2019 and 2020.

Total Annual Construction Emission - Training, Alternative C and IT

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Training + Alternative C + IT	2017	0.0	0.1	3.5	0.3	0.3	5.3	0.7	724.7
	2018	0.1	0.3	21.9	1.4	1.3	16.3	3.2	3176.9
	2019	0.3	0.7	48.4	2.9	2.6	34.3	5.7	7625.4
	2020	0.1	0.3	24.6	1.4	1.3	15.9	3.2	3540.8
	2021	0.2	0.5	30.3	1.8	1.6	23.5	3.1	5219.8
	2022	0.2	0.5	30.8	1.9	1.7	23.9	3.2	5309.8

Training will take place during first two years of the construction phase. Therefore, training related emissions are only applied to years 2017 and 2018 after distributing them equally.

IT/Comm related emissions are applied to year 2018, 2019 and 2020.

Total Annual Construction Emission - Training, Alternative D and IT

	Construction Year	Max CY Ratio	Pollutant (tpy)						
			SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Training + Alternative D + IT	2017	0.0	0.1	4.8	0.4	0.4	6.2	0.8	933.6
	2018	0.1	0.5	31.3	2.0	1.8	23.6	4.2	4784.0
	2019	0.3	0.6	43.9	2.6	2.3	30.8	5.2	6825.0
	2020	0.1	0.3	20.3	1.2	1.0	12.5	2.8	2779.4
	2021	0.3	0.7	41.4	2.5	2.2	32.1	4.3	7096.1
	2022	0.2	0.3	19.0	1.2	1.0	14.7	2.0	3256.3

Training will take place during first two years of the construction phase. Therefore, training related emissions are only applied to years 2017 and 2018 after distributing them equally.

IT/Comm related emissions are applied to year 2018, 2019 and 2020.

On-Site Construction

PM Emission Rates Estimate

Guam AERMOD Emission Rates

Construction Equipment AERMOD Emission Rates – Alternative B (Non Housing – Finegayan)

Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)		Max Month Multiplier	Max Calendar Year Multiplier	Daily Emission Rate (g/s)		Annual Emission Rate (g/s)		Finegayan Area (m^2)	Daily Emission Rate ($g/s/m^2$)		Annual Emission Rate ($g/s/m^2$)	
						PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Construction Equipment Emissions																		
Asphalt paver, 130 HP	1	529	4232	130	59	0.33	0.32	0.048	0.36	0.0020	0.0019	0.0018	0.0018	4648422.6	4.3E-10	4.2E-10	3.9E-10	3.8E-10
Backhoe loader, 48hp	1	1544	12352	48	21	1.00	0.97	0.048	0.36	0.0023	0.0022	0.0021	0.0020	4648422.6	5.0E-10	4.8E-10	4.5E-10	4.4E-10
Centrif. water pump, 6"	1	22	176	57	43	0.24	0.23	0.048	0.36	0.0000	0.0000	0.0000	0.0000	4648422.6	4.1E-12	4.0E-12	3.8E-12	3.6E-12
Chain saws, 36"	1	744	5952	7	70	9.76	8.98	0.048	0.36	0.0051	0.0047	0.0047	0.0043	4648422.6	1.1E-09	1.0E-09	1.0E-09	9.2E-10
Chipping machine	1	372	2976	144	43	0.45	0.43	0.048	0.36	0.0015	0.0015	0.0014	0.0013	4648422.6	3.3E-10	3.2E-10	3.0E-10	2.9E-10
Compressor, 250 cfm	1	7506	60048	90	43	0.38	0.37	0.048	0.36	0.0165	0.0160	0.0150	0.0145	4648422.6	3.5E-09	3.4E-09	3.2E-09	3.1E-09
Concrete pump, small	1	1673	13384	53	43	0.57	0.56	0.048	0.36	0.0032	0.0031	0.0029	0.0028	4648422.6	6.9E-10	6.7E-10	6.3E-10	6.1E-10
Crane, 90-tons	1	890	7120	225	43	0.21	0.20	0.048	0.36	0.0027	0.0026	0.0024	0.0024	4648422.6	5.8E-10	5.6E-10	5.3E-10	5.1E-10
Crane, SP, 12 ton	1	2840	22720	175	43	0.21	0.20	0.048	0.36	0.0067	0.0065	0.0061	0.0059	4648422.6	1.4E-09	1.4E-09	1.3E-09	1.3E-09
Crane, SP, 5 ton	1	2070	16560	175	43	0.21	0.20	0.048	0.36	0.0049	0.0047	0.0044	0.0043	4648422.6	1.0E-09	1.0E-09	9.5E-10	9.2E-10
Crane, 40 ton	1	226	1808	282	43	0.21	0.20	0.048	0.36	0.0009	0.0008	0.0008	0.0008	4648422.6	1.8E-10	1.8E-10	1.7E-10	1.6E-10
Drill rig & augers	1	114	912	176	43	0.18	0.17	0.048	0.36	0.0002	0.0002	0.0002	0.0002	4648422.6	4.9E-11	4.8E-11	4.5E-11	4.4E-11
Dozer, 300 HP	1	593	4744	300	59	0.30	0.29	0.048	0.36	0.0046	0.0045	0.0042	0.0041	4648422.6	9.9E-10	9.6E-10	9.0E-10	8.7E-10
Front end loader, 1.5 cy	1	593	4744	243	59	0.33	0.32	0.048	0.36	0.0041	0.0040	0.0038	0.0037	4648422.6	8.9E-10	8.7E-10	8.1E-10	7.9E-10
Front end loader, TM, 2.5cy	1	372	2976	243	59	0.33	0.32	0.048	0.36	0.0026	0.0025	0.0024	0.0023	4648422.6	5.6E-10	5.4E-10	5.1E-10	4.9E-10
Gas engine vibrator	1	2301	18408	2	55	7.64	7.03	0.048	0.36	0.0024	0.0022	0.0021	0.0020	4648422.6	5.1E-10	4.7E-10	4.6E-10	4.3E-10
Gas welding machine	1	2328	18624	66	68	0.06	0.06	0.048	0.36	0.0009	0.0009	0.0008	0.0008	4648422.6	1.9E-10	1.9E-10	1.7E-10	1.7E-10
Gradall, 3 ton, 1/2 cy	1	574	4592	125	59	0.31	0.30	0.048	0.36	0.0019	0.0019	0.0018	0.0017	4648422.6	4.1E-10	4.0E-10	3.8E-10	3.7E-10
Gradder, 30000 lb	1	1732	13856	204	59	0.28	0.27	0.048	0.36	0.0086	0.0084	0.0078	0.0076	4648422.6	1.9E-09	1.8E-09	1.7E-09	1.6E-09
Hydraulic excavator, 3.5 cy	1	126	1008	171	59	0.29	0.28	0.048	0.36	0.0005	0.0005	0.0005	0.0005	4648422.6	1.2E-10	1.1E-10	1.1E-10	1.0E-10
Pneumatic wheel roller	1	529	4232	99	59	0.24	0.23	0.048	0.36	0.0011	0.0011	0.0010	0.0010	4648422.6	2.4E-10	2.3E-10	2.1E-10	2.1E-10
Vibratory roller	1	593	4744	92.3	59	0.41	0.40	0.048	0.36	0.0020	0.0019	0.0018	0.0017	4648422.6	4.2E-10	4.1E-10	3.8E-10	3.7E-10
Rollers, steel wheel	1	1058	8464	92	59	0.41	0.40	0.048	0.36	0.0035	0.0034	0.0032	0.0031	4648422.6	7.5E-10	7.3E-10	6.8E-10	6.6E-10
Total Emissions										0.08	0.08	0.07	0.07		1.68E-08	1.62E-08	1.53E-08	1.48E-08

Notes
Days per month: 30
Day per year: 250

Construction Equipment AERMOD Emission Rates – Alternative B (Housing – South Finegayan)

Equipment Type	Number of Units	Days	Hours	Horsepower (hp)	Load Factor (%)	Emission Factor (grams/hp-hour)		Max Month Multiplier	Max Calendar Year Multiplier	Daily Emission Rate (g/s)		Annual Emission Rate (g/s)		South Finegayan Area (m^2)	Daily Emission Rate ($g/s/m^2$)		Annual Emission Rate ($g/s/m^2$)	
						PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Construction Equipment Emissions																		
Asphalt paver, 130 HP	1	52	416	130	59	0.33	0.32	0.048	0.36	0.00020	0.00019	0.00018	0.00017	4796082.5	4.1E-11	4.0E-11	3.7E-11	3.6E-11
Backhoe loader, 48hp	1	151	1208	48	21	1.00	0.97	0.048	0.36	0.00023	0.00022	0.00021	0.00020	4796082.5	4.7E-11	4.6E-11	4.3E-11	4.2E-11
Centrif. water pump, 6"	1	82	656	57	43	0.24	0.23	0.048	0.36	0.00007	0.00007	0.00006	0.00006	4796082.5	1.5E-11	1.4E-11	1.4E-11	1.3E-11
Chain saws, 36"	1	41	328	7	70	9.76	8.98	0.048	0.36	0.00028	0.00026	0.00026	0.00024	4796082.5	5.9E-11	5.4E-11	5.4E-11	4.9E-11
Compressor, 250 cfm	1	4431	35448	90	43	0.38	0.37	0.048	0.36	0.00971	0.00942	0.00883	0.00857	4796082.5	2.0E-09	2.0E-09	1.8E-09	1.8E-09
Crane, SP, 12 ton	1	270	2160	175	43	0.21	0.20	0.048	0.36	0.00063	0.00061	0.00058	0.00056	4796082.5	1.3E-10	1.3E-10	1.2E-10	1.2E-10
Crane, SP, 5 ton	1	126	1008	175	43	0.21	0.20	0.048	0.36	0.00030	0.00029	0.00027	0.00026	4796082.5	6.2E-11	6.0E-11	5.6E-11	5.4E-11
Dozer, 300 HP	1	63	504	282	43	0.21	0.20	0.048	0.36	0.00024	0.00023	0.00022	0.00021	4796082.5	5.0E-11	4.8E-11	4.5E-11	4.4E-11
Front end loader, 1.5 cy	1	63	504	243	59	0.33	0.32	0.048	0.36	0.00044	0.00043	0.00040	0.00039	4796082.5	9.2E-11	8.9E-11	8.4E-11	8.1E-11
Front end loader, TM, 2.5cy	1	41	328	243	59	0.33	0.32	0.048	0.36	0.00029	0.00028	0.00026	0.00025	4796082.5	6.0E-11	5.8E-11	5.4E-11	5.3E-11
Gas engine vibrator	1	187	1496	2	55	7.64	7.03	0.048	0.36	0.00019	0.00018	0.00017	0.00016	4796082.5	4.0E-11	3.7E-11	3.6E-11	3.4E-11
Gradall, 3 ton, 1/2 cy	1	56	448	125	59	0.31	0.30	0.048	0.36	0.00019	0.00018	0.00017	0.00017	4796082.5	3.9E-11	3.8E-11	3.6E-11	3.5E-11
Gradder, 30000 lb	1	183	1464	204	59	0.28	0.27	0.048	0.36	0.00091	0.00088	0.00083	0.00080	4796082.5	1.9E-10	1.8E-10	1.7E-10	1.7E-10
Pneumatic wheel roller	1	52	416	99	59	0.24	0.23	0.048	0.36	0.00011	0.00010	0.00010	0.00010	4796082.5	2.3E-11	2.2E-11	2.0E-11	2.0E-11
Vibratory roller	1	63	504	92.3	59	0.41	0.40	0.048	0.36	0.00021	0.00020	0.00019	0.00018	4796082.5	4.3E-11	4.2E-11	4.0E-11	3.8E-11
Rollers, steel wheel	1	104	832	92	59	0.41	0.40	0.048	0.36	0.00034	0.00033	0.00031	0.00030	4796082.5	7.2E-11	7.0E-11	6.5E-11	6.3E-11
Total Emissions										0.01	0.01	0.01	0.01		2.99E-09	2.89E-09	2.72E-09	2.63E-09
Notes Days per month: 30 Day per year: 250																		

On-Site Vehicle AERMOD Emission Rates – Alternative B (Non Housing – Finegayan)

	Total Vehicle Trips	Total Roundtrip Miles	Emission Factor (g/mi)		Emissions (g/roundtrip)		Max Month Multiplier	Max Calendar Year Multiplier	Daily Emission Rate (g/s)		Annual Emission Rate (g/s)		Finegayan Area (m^2)	Daily Emission Rate ($g/s/m^2$)		Annual Emission Rate ($g/s/m^2$)	
			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
On Site Vehicle[1]																	
Trucks	116448	6	2.06	1.13	12.39	6.78	0.048	0.36	0.027	0.015	0.024	0.013	4648422.6	5.7E-09	3.1E-09	5.2E-09	2.9E-09
Cars	472439	6	0.14	0.04	0.81	0.25	0.048	0.36	0.007	0.002	0.006	0.002	4648422.6	1.5E-09	4.7E-10	1.4E-09	4.3E-10
Total motor vehicle emissions									0.03	0.02	0.03	0.02		7.27E-09	3.62E-09	6.62E-09	3.29E-09

Assumptions
1. Onsite vehicles speed: 5 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day
Days per month: 30
Day per year: 250

On-Site Vehicle AERMOD Emission Rates – Alternative B (Housing – South Finegayan)

	Total Vehicle Trips	Total Roundtrip Miles	Emission Factor (g/mi)		Emissions (g/roundtrip)		Max Month Multiplier	Max Calendar Year Multiplier	Daily Emission Rate (g/s)		Annual Emission Rate (g/s)		South Finegayan Area (m^2)	Daily Emission Rate ($g/s/m^2$)		Annual Emission Rate ($g/s/m^2$)	
			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
On Site Vehicle[1]																	
Trucks	13354	3.5	2.06	1.13	7.23	3.96	0.048	0.36	0.002	0.001	0.002	0.001	4796082.5	3.7E-10	2E-10	3.4E-10	1.9E-10
Cars	91011	3.5	0.14	0.04	0.47	0.15	0.048	0.36	0.001	0.000	0.001	0.000	4796082.5	1.7E-10	5.1E-11	1.5E-10	4.7E-11
Total motor vehicle emissions									0.00	0.00	0.00	0.00		5.39E-10	2.55E-10	4.90E-10	2.32E-10

Assumption
1. Onsite vehicles speed: 5 mph
3. Roadway type: Rural unrestricted
4. Off site trucks includes material delivery trucks and dump trucks running 20 miles round trip
5. Off site passenger cars are running 20 miles round trip
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day
Days per month: 30
Day per year: 250

On-Site Vehicle Fugitive Dust AERMOD Emission Rates – Alternative B

Vehicle Type	Days	Total Roundtrip Miles per Veh	Max Month Multiplier	Max Calendar Year Multiplier			Paved – Uncontrolled Emissions[3]										
					PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	PM_{10} Emissions	$PM_{2.5}$ Emissions[5]	Daily PM_{10} Emissions	Daily $PM_{2.5}$ Emissions[5]	Annual PM_{10} Emissions	Annual $PM_{2.5}$ Emissions[5]	Finegayan Area	Daily PM_{10} Emissions	Daily $PM_{2.5}$ Emissions[5]	Annual PM_{10} Emissions	Annual $PM_{2.5}$ Emissions[5]
					lb/VMT	lb/VMT[5]	lb/veh	lb/veh	g/s	g/s	g/s	g/s	m^2	$g/s/m^2$	$g/s/m^2$	$g/s/m^2$	$g/s/m^2$
Finegayan																	
Trucks	116448	6	0.048	0.36	0.18	0.03	1.06	0.16	2.29E-03	3.40E-04	2.09E-03	3.10E-04	4648422.6	**4.93E-10**	**7.32E-11**	**4.49E-10**	**6.66E-11**
Cars	472439	6	0.048	0.36	0.0026	9.89E-05	0.02	0.00	1.36E-04	5.19E-06	1.24E-04	4.72E-06		**2.92E-11**	**1.12E-12**	**2.66E-11**	**1.02E-12**
Total									2.43E-03	3.46E-04	2.21E-03	3.14E-04		5.23E-10	7.43E-11	4.75E-10	6.76E-11
South Finegayan																	
Trucks	13354	6	0.048	0.36	0.18	0.03	1.06	0.16	1.19E-01	1.77E-02	1.09E-01	1.61E-02	4796082.5	**2.49E-08**	**3.69E-09**	**2.26E-08**	**3.36E-09**
Cars	91011	6	0.048	0.36	0.0026	9.89E-05	0.02	0.00	1.19E-02	4.54E-04	1.08E-02	4.13E-04		**2.48E-09**	**9.46E-11**	**2.25E-09**	**8.61E-11**
Total									1.31E-01	1.82E-02	1.19E-01	1.65E-02		2.74E-08	3.79E-09	2.49E-08	3.44E-09

Assumptions
1. Onsite vehicles speed: 5 mph
6. On site trucks includes water trucks and tractor trucks, running 8 hours a day
Days per month: 30
Day per year: 250

Notes:
1. Mileage based on round trip between access location and on-site work location
2. The weight of the empty (incoming) and full load (outgoing) 10 cy truck are 20 and 40 tons, respectively. The trucks average is assumed to be 30 tons.
3. These emission rates are based on a maximum distance traveled in one hour; average annual emission rates are likely to be much less.
4. Includes 50% reduction credit for use of water spray controls on-site.
5. PM2.5 emissions are zero for equipment traveling less then 5 mph.
6. Controlled PM10 emissions are 75% controlled for equipment traveling less then 5 mph (This includes a reduction credit for use of water spray controls on-site.)

Paved Road Emission Factor - Sample Calculation (trucks):
$E_f = k * (sL/2)^{0.65} * (W/3)^{1.5} - C$
Equation 1 from Section 13.2.1 of USEPA's AP-42
where:
E_f = size specific emission factor in pounds per vehicle mile traveled (lb/VMT)
k = an empirical constant selected from AP-42 Table 13.2.1-1 for PM_{10} and $PM_{2.5}$ = 0.016 and 0.0024.
sL = road surface silt loading in grams per square meter selected from FSEIS = 0.4
W = mean vehicle weight in tons = 30 tons
C = Emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear selected from AP-42 Table 13.2.1-2 for PM10 and PM2.5 = 0.00047 and 0.00036.
$PM10E_f = 0.016 * (0.4/2)^{0.65} * (30/3)^{1.5} - 0.00047$
E_f = 0.18 lb/VMT

Constant	PM10	PM2.5
k	0.016	0.0024
sL	0.4	0.4
C	0.00047	0.00036
W (Trucks)	30	**30**
W (Cars)	2	2

Sample Emission Rate Calculation (trucks):
$E_R = (E_f \text{ paved} * VMT) * 453.59 \text{ (g/lb)} / 60 \text{ (min/hr)} / 60 \text{ (s/min)}$
where:
E_R = PM_{10} emission rate in grams per second

Grading Fugitive Dust AERMOD Emission Rates – Alternative B

											Uncontrolled Emissions				
Pollutant	Particle Size Multiplier (K)	Wind Speed (mph)	Moisture Content (%)	Total Constructio n area (sq. yd)	Grading Depth (yd)	Total Material volume (cu. yd)	Total Weight (tons)[5]	Emission Factor (lb/ton)[6]	Max Month Multiplier	Max Calendar Year Multiplier	Daily Emissions (g/s)	Annual Emissions (g/s)	Finegayan Area (m^2)	Daily Emissions (g/s)	Annual Emissions (g/s)
Finegayan															
PM10	0.35	12	11	5074074.6	1	5,074,075	7192501	0.00032	0.048	0.36	0.01942	0.01766	4648422.6	4.18E-09	3.80E-09
PM2.5	0.053							0.00005	0.048	0.36	0.00294	0.00267		6.33E-10	5.75E-10
South Finegayan															
PM10	0.35	12	11	535040	1	535,040	758419	0.00032	0.048	0.36	0.00205	0.00186	4796082.5	4.27E-10	3.88E-10
PM2.5	0.053							0.00005	0.048	0.36	0.00031	0.00028		6.46E-11	5.88E-11

Notes:
3. Fugitive dust mitigation from water spraying earns a 50% reduction credit.
5. Total Wieght of material is based on AP-42 Appendix A density of Sand, Gravel (Dry, loose) of 90 to 105 lb/ft3.
6. Emission factors for soil transfer operations are based on Equation 1 from Section 13.2.4 of AP-42. Emission factor calculations are provided below.
7. Material load to the pile and from pile to the truck is considered as two drops operations.

Days per month: 30
Day per year: 250
EF (lb/ton) = k * (0.0032) * (u/5)1.3 / (M/2)1.4
where: EF = emission factor;
k = particle size multiplier (0.35 for PM10 and 0.053 for PM2.5);
U = mean wind speed (mile/hour) =10 mph
M = material moisture content (%) = 11%
http://www.windfinder.com/windstats/windstatistic_yigo_guam.htm
`

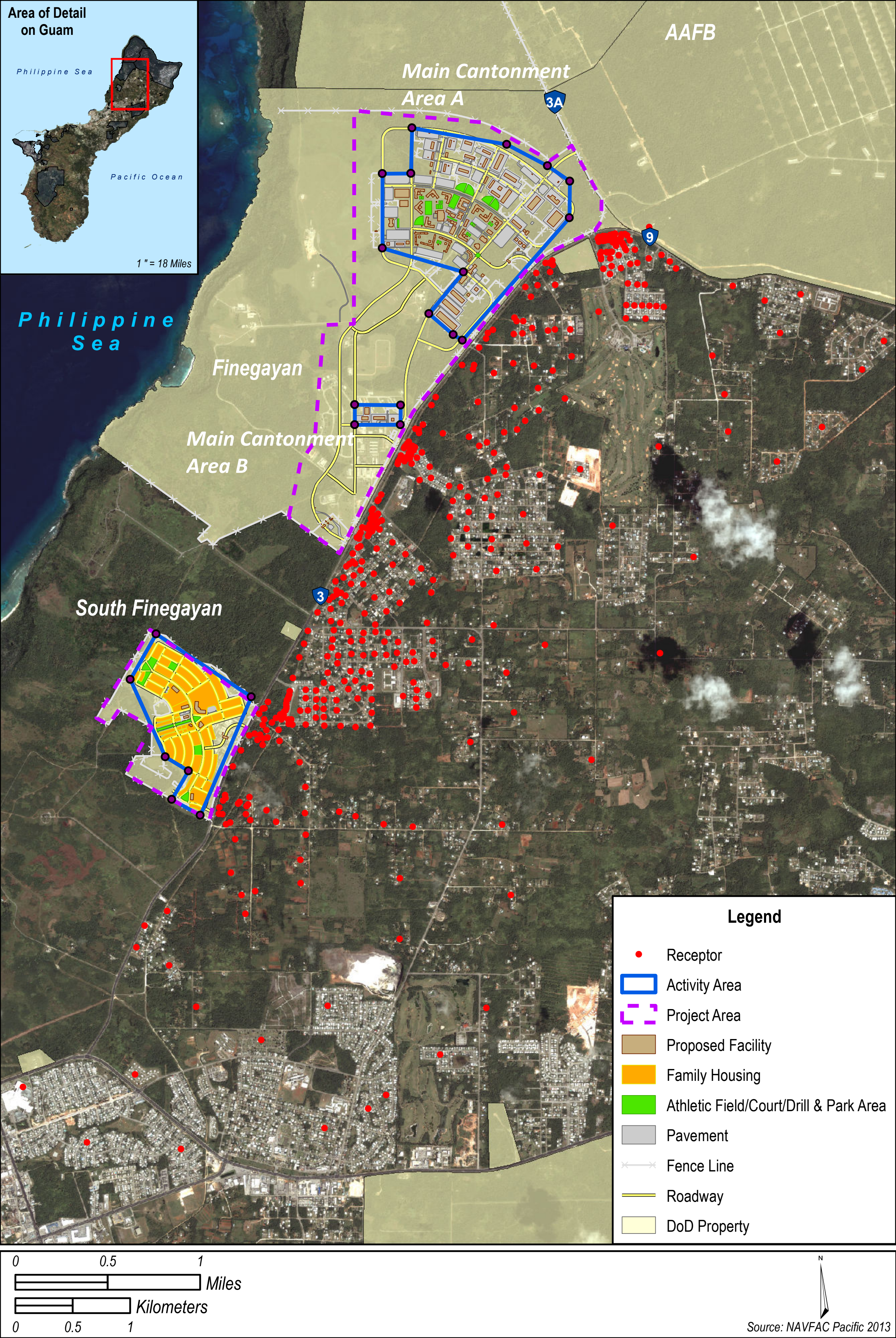
AERMOD Emission Rates

Activity	g/s							
	Alt B Finegayan				Alt B South Finegayan			
	PM10		PM2.5		PM10		PM2.5	
	Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
Construction Equipment Emissions	7.82E-02	7.11E-02	7.55E-02	6.87E-02	1.43E-02	1.30E-02	1.39E-02	1.26E-02
Vehicle Emissions	3.38E-02	3.08E-02	1.68E-02	1.53E-02	2.58E-03	2.35E-03	1.22E-03	1.11E-03
Vehicle Fugitive Dust	2.43E-03	2.21E-03	3.46E-04	3.14E-04	1.31E-01	1.19E-01	1.82E-02	1.65E-02
Earth Movement Fugitive Dust	1.94E-02	1.77E-02	2.94E-03	2.67E-03	2.05E-03	1.86E-03	3.10E-04	2.82E-04
Total	1.34E-01	1.22E-01	9.56E-02	8.69E-02	1.50E-01	1.37E-01	3.36E-02	3.05E-02

Source Area	Area (m2)	Emission Rate (g/s/m2)							
		PM10		PM2.5		PM10		PM2.5	
		Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
Alt A - Finegayan Total Area	1963717	*6.82E-08*	*6.20E-08*	*4.87E-08*	*4.43E-08*				
Alt A - Finegayan Area A	1895225	6.58E-08	5.98E-08	4.70E-08	4.27E-08	-	-	-	-
Alt A - Finegayan Area B	68492	2.38E-09	2.16E-09	1.70E-09	1.54E-09	-	-	-	-
Alt A - South Finegayan	712404	-	-	-	-	2.11E-07	1.92E-07	4.71E-08	4.29E-08
Alt B - Finegayan Total Area	1862692	*7.19E-08*	*6.53E-08*	*5.13E-08*	*4.67E-08*				
Alt B - Finegayan Area A	1794200	6.92E-08	6.29E-08	4.94E-08	4.50E-08	-	-	-	-
Alt B - Finegayan Area B	68492	2.64E-09	2.40E-09	1.89E-09	1.72E-09	-	-	-	-
Alt B - South Finegayan	834078	-	-	-	-	1.80E-07	1.64E-07	4.02E-08	3.66E-08

On-Site Construction

AERMOD Model Sample Input/Output



Area of Detail on Guam
Philippine Sea
Pacific Ocean
1 " = 18 Miles
AAFB
Main Cantonment Area A
3A
9
Philippine Sea
Finegayan
Main Cantonment Area B
3
South Finegayan
Legend
Receptor
Activity Area
Project Area
Proposed Facility
Family Housing
Athletic Field/Court/Drill & Park Area
Pavement
Fence Line
Roadway
DoD Property
0
0.5
1
Miles
Kilometers
0
0.5
1
N
Source: NAVFAC Pacific 2013

AERMOD Alternative B Input

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CO TITLEONE Title One
CO MODELOPT DFAULT CONC
CO AVERTIME 24
CO POLLUTID PM2.5_24
CO RUNORNOT RUN
CO FINISHED
 SO STARTING
SO ELEVUNIT METERS
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SO SRCPARAM FINEGAYAN_A 4.94E-08 0. 12
SO AREAVERT FINEGAYAN_A 268444.26 1503836.27
SO AREAVERT FINEGAYAN_A 268637.86 1503702.3
SO AREAVERT FINEGAYAN_A 268635.13 1503383.59
SO AREAVERT FINEGAYAN_A 267701.61 1502317.81
SO AREAVERT FINEGAYAN_A 267621.8 1502367.53
SO AREAVERT FINEGAYAN_A 267412.05 1502550.04
SO AREAVERT FINEGAYAN_A 267711.69 1502912.33
SO AREAVERT FINEGAYAN_A 267006.17 1503119.36
SO AREAVERT FINEGAYAN_A 267006.17 1503767.68
SO AREAVERT FINEGAYAN_A 267254.05 1503770.4
SO AREAVERT FINEGAYAN_A 267263.3 1504166.02
SO AREAVERT FINEGAYAN_A 268089.31 1504022.13
** Finegayan - Main Cantonment Area B
SO LOCATION FINEGAYAN_B AREAPOLY 267163.58 1501752.56 0.
SO SRCPARAM FINEGAYAN_B 1.89E-09 0. 4
SO AREAVERT FINEGAYAN_B 267163.58 1501752.56
SO AREAVERT FINEGAYAN_B 267162.87 1501582.55
SO AREAVERT FINEGAYAN_B 266764.39 1501583.32
SO AREAVERT FINEGAYAN_B 266765.31 1501757.16
** South Finegayan - Housing
SO LOCATION S_FINEGAYAN AREAPOLY 265863.06 1499213.15 0.
SO SRCPARAM S_FINEGAYAN 4.02E-08 0. 7
SO AREAVERT S_FINEGAYAN 265863.06 1499213.15
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SO AREAVERT S_FINEGAYAN 265170.52 1498320.54
SO AREAVERT S_FINEGAYAN 265316.78 1498569.19
SO AREAVERT S_FINEGAYAN 265114.18 1498692.2
SO AREAVERT S_FINEGAYAN 264810.29 1499365.1
SO AREAVERT S_FINEGAYAN 265035.04 1499760.93
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SO FINISHED

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ME SURFDATA  41415 2008
ME UAIRDATA  99999 2008
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ME PROFBASE 72 METERS
ME FINISHED

AERMOD Alternative B Output

```
**BEE-Line Software: BEEST for Windows (Version 9.91) data input file
**  Model: AERMOD.EXE     Input File Creation Date: 10/22/2013  Time: 5:54:35 PM
NO ECHO


 BEE-Line AERMOD "BEEST" Version ****


 Input File - C:\Users\BrownworthB\Desktop\Brian_Brownworth\Guam_Revision\AERMOD\Alt_B\102213\Guam_AltB_2008_PM2.5_24.D
            TA
Output File - C:\Users\BrownworthB\Desktop\Brian_Brownworth\Guam_Revision\AERMOD\Alt_B\102213\Guam_AltB_2008_PM2.5_24.L
            ST
  Met File - C:\Users\BrownworthB\Desktop\Brian Brownworth\Guam_Revision\Met data\Guam met\PGUMA_08.SFC


***********************************
*** SETUP Finishes Successfully ***
***********************************

*** AERMOD - VERSION  11103 ***   *** Title One                          ***       10/22/13
                      ***                                        ***       18:11:05
                                                                      PAGE   1
**MODELOPTs:  RegDFAULT CONC                              ELEV


                            ***     MODEL SETUP OPTIONS SUMMARY      ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Model Is Setup For Calculation of Average CONCentration Values.

  --  DEPOSITION LOGIC  --
**NO GAS DEPOSITION Data Provided.
**NO PARTICLE DEPOSITION Data Provided.
**Model Uses NO DRY DEPLETION.  DRYDPLT  =  F
**Model Uses NO WET DEPLETION.  WETDPLT  =  F

**Model Uses RURAL Dispersion Only.

**Model Uses Regulatory DEFAULT Options:
     1. Stack-tip Downwash.
     2. Model Accounts for ELEVated Terrain Effects.
     3. Use Calms Processing Routine.
     4. Use Missing Data Processing Routine.
     5. No Exponential Decay.
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**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates 1 Short Term Average(s) of: 24-HR

**This Run Includes: 3 Source(s); 1 Source Group(s); and 412 Receptor(s)

**The Model Assumes A Pollutant Type of: PM2.5_24

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)
Model Outputs Separate Summary File of High Ranked Values (SUMMFILE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Base Elev. for Pot. Temp. Profile (m MSL) = 72.00 ; Decay Coef. = 0.000 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3

**Approximate Storage Requirements of Model = 3.6 MB of RAM.

**Input Runstream File: Guam_AltB_2008_PM2.5_24.DTA
**Output Print File: Guam_AltB_2008_PM2.5_24.LST

**File for Summary of Results: C:\Users\BrownworthB\Desktop\Brian_Brownworth\Guam_Revision\AERMOD\Alt_B\102213\Guam_AltB_2008_P

*** AERMOD - VERSION 11103 *** *** Title One *** 10/22/13
*** *** 18:11:05
PAGE 2
**MODELOPTs: RegDFAULT CONC ELEV

*** AREAPOLY SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	LOCATION OF AREA X (METERS)	LOCATION OF AREA Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	NUMBER OF VERTS.	INIT. SZ (METERS)	URBAN SOURCE	EMISSION RATE SCALAR VARY BY
FINEGAYAN_A	0	0.49400E-07	268444.3	1503836.3	0.0	0.00	12	0.00	NO	
FINEGAYAN_B	0	0.18900E-08	267163.6	1501752.6	0.0	0.00	4	0.00	NO	
S_FINEGAYAN	0	0.40200E-07	265863.1	1499213.2	0.0	0.00	7	0.00	NO	

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*** AERMOD - VERSION  11103 ***   *** Title One                                   ***       10/22/13
                       ***                                          ***       18:11:05
                                                                        PAGE   3
**MODELOPTs:  RegDFAULT CONC                              ELEV



                              *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                    SOURCE IDs



 ALL      FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** AERMOD - VERSION  11103 ***   *** Title One                                   ***       10/22/13
                       ***                                          ***       18:11:05
                                                                        PAGE   4
**MODELOPTs:  RegDFAULT CONC                              ELEV



                               *** DISCRETE CARTESIAN RECEPTORS ***
                              (X-COORD, Y-COORD, ZELEV, ZHILL, ZFLAG)
                                         (METERS)

   ( 269137.8, 1503231.4,      1.5,      0.0,      0.0);       ( 268963.8, 1503220.4,      1.5,      0.0,      0.0);
   ( 268956.2, 1503088.0,      1.5,      0.0,      0.0);       ( 268928.8, 1502939.2,      1.5,      0.0,      0.0);
   ( 268990.1, 1503033.3,      1.5,      0.0,      0.0);       ( 269001.0, 1502967.7,      1.5,      0.0,      0.0);
   ( 268987.9, 1502896.5,      1.5,      0.0,      0.0);       ( 269083.1, 1502946.9,      1.5,      0.0,      0.0);
   ( 269062.3, 1503059.6,      1.5,      0.0,      0.0);       ( 269040.4, 1503140.6,      1.5,      0.0,      0.0);
   ( 269127.9, 1503104.4,      1.5,      0.0,      0.0);       ( 269205.6, 1503107.7,      1.5,      0.0,      0.0);
   ( 269165.1, 1502985.2,      1.5,      0.0,      0.0);       ( 269226.4, 1502992.8,      1.5,      0.0,      0.0);
   ( 269326.0, 1503030.0,      1.5,      0.0,      0.0);       ( 269436.5, 1503064.0,      1.5,      0.0,      0.0);
   ( 269329.3, 1503306.9,      1.5,      0.0,      0.0);       ( 269507.6, 1503004.9,      1.5,      0.0,      0.0);
   ( 269562.3, 1502944.7,      1.5,      0.0,      0.0);       ( 269143.3, 1502813.4,      1.5,      0.0,      0.0);
   ( 269226.4, 1502805.7,      1.5,      0.0,      0.0);       ( 269291.0, 1502803.5,      1.5,      0.0,      0.0);
   ( 269129.0, 1502625.2,      1.5,      0.0,      0.0);       ( 269199.1, 1502620.8,      1.5,      0.0,      0.0);
   ( 269266.9, 1502621.9,      1.5,      0.0,      0.0);       ( 269331.5, 1502619.7,      1.5,      0.0,      0.0);
   ( 269390.5, 1502616.4,      1.5,      0.0,      0.0);       ( 269124.7, 1502510.3,      1.5,      0.0,      0.0);
   ( 269297.5, 1502507.0,      1.5,      0.0,      0.0);       ( 269456.2, 1502609.9,      1.5,      0.0,      0.0);
   ( 268509.7, 1502801.4,      1.5,      0.0,      0.0);       ( 268297.5, 1502698.5,      1.5,      0.0,      0.0);
   ( 268149.7, 1502373.5,      1.5,      0.0,      0.0);       ( 268224.1, 1502379.0,      1.5,      0.0,      0.0);
   ( 268309.5, 1502426.0,      1.5,      0.0,      0.0);       ( 268232.9, 1502486.2,      1.5,      0.0,      0.0);
   ( 268448.4, 1502403.1,      1.5,      0.0,      0.0);       ( 268507.5, 1502414.0,      1.5,      0.0,      0.0);
   ( 268642.1, 1502412.9,      1.5,      0.0,      0.0);       ( 268653.1, 1502178.8,      1.5,      0.0,      0.0);
   ( 268487.8, 1502055.1,      1.5,      0.0,      0.0);       ( 268144.3, 1502117.5,      1.5,      0.0,      0.0);
   ( 268325.9, 1502097.8,      1.5,      0.0,      0.0);       ( 267976.9, 1502035.4,      1.5,      0.0,      0.0);
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( 268360.9, 1501905.2,     1.5,     0.0,     0.0);      ( 268596.2, 1501813.3,     1.5,     0.0,     0.0);
( 267848.8, 1501400.8,     1.5,     0.0,     0.0);      ( 267916.7, 1501430.3,     1.5,     0.0,     0.0);
( 267758.0, 1501477.4,     1.5,     0.0,     0.0);      ( 268064.4, 1501517.9,     1.5,     0.0,     0.0);
( 268177.1, 1501540.9,     1.5,     0.0,     0.0);      ( 268156.3, 1501732.3,     1.5,     0.0,     0.0);
( 268247.1, 1501618.5,     1.5,     0.0,     0.0);      ( 268366.4, 1501711.5,     1.5,     0.0,     0.0);
( 267976.9, 1501340.6,     1.5,     0.0,     0.0);      ( 267836.8, 1501782.7,     1.5,     0.0,     0.0);
( 267531.5, 1501510.2,     1.5,     0.0,     0.0);      ( 267358.6, 1501583.5,     1.5,     0.0,     0.0);
( 267194.5, 1501382.2,     1.5,     0.0,     0.0);      ( 267348.8, 1501343.9,     1.5,     0.0,     0.0);
( 267307.2, 1501296.8,     1.5,     0.0,     0.0);      ( 267151.8, 1501275.0,     1.5,     0.0,     0.0);
( 267260.2, 1501246.5,     1.5,     0.0,     0.0);      ( 267428.7, 1501121.8,     1.5,     0.0,     0.0);
( 267330.2, 1501103.2,     1.5,     0.0,     0.0);      ( 267417.7, 1501217.0,     1.5,     0.0,     0.0);
( 267586.2, 1501052.8,     1.5,     0.0,     0.0);      ( 267618.0, 1500922.6,     1.5,     0.0,     0.0);
( 267682.5, 1501041.9,     1.5,     0.0,     0.0);      ( 267591.7, 1500780.4,     1.5,     0.0,     0.0);
( 267920.0, 1501113.0,     1.5,     0.0,     0.0);      ( 267748.2, 1500956.6,     1.5,     0.0,     0.0);
( 267895.9, 1500945.6,     1.5,     0.0,     0.0);      ( 267756.9, 1500824.2,     1.5,     0.0,     0.0);
( 267739.4, 1500679.7,     1.5,     0.0,     0.0);      ( 267600.5, 1500593.3,     1.5,     0.0,     0.0);
( 267623.4, 1500446.7,     1.5,     0.0,     0.0);      ( 267750.4, 1500524.4,     1.5,     0.0,     0.0);
( 267951.7, 1500502.5,     1.5,     0.0,     0.0);      ( 267958.3, 1500587.8,     1.5,     0.0,     0.0);
( 267957.2, 1500789.1,     1.5,     0.0,     0.0);      ( 268006.4, 1500975.2,     1.5,     0.0,     0.0);
( 268078.6, 1501148.0,     1.5,     0.0,     0.0);      ( 268086.3, 1501214.8,     1.5,     0.0,     0.0);
( 267976.9, 1501178.7,     1.5,     0.0,     0.0);      ( 266829.9, 1500692.1,     1.5,     0.0,     0.0);
( 266783.0, 1500604.3,     1.5,     0.0,     0.0);      ( 266441.2, 1499951.0,     1.5,     0.0,     0.0);
( 266497.1, 1500094.7,     1.5,     0.0,     0.0);      ( 266607.5, 1500106.8,     1.5,     0.0,     0.0);

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**MODELOPTs:  RegDFAULT CONC                                 ELEV



                         *** DISCRETE CARTESIAN RECEPTORS ***
                        (X-COORD, Y-COORD, ZELEV, ZHILL, ZFLAG)
                                     (METERS)

( 266554.6, 1499981.2,     1.5,     0.0,     0.0);      ( 266557.6, 1499876.9,     1.5,     0.0,     0.0);
( 266639.3, 1499860.2,     1.5,     0.0,     0.0);      ( 266649.9, 1500034.2,     1.5,     0.0,     0.0);
( 266595.4, 1500218.7,     1.5,     0.0,     0.0);      ( 266690.7, 1500351.8,     1.5,     0.0,     0.0);
( 266746.7, 1500465.2,     1.5,     0.0,     0.0);      ( 266929.7, 1500286.7,     1.5,     0.0,     0.0);
( 267065.8, 1500127.9,     1.5,     0.0,     0.0);      ( 267156.5, 1500032.7,     1.5,     0.0,     0.0);
( 267040.1, 1499958.6,     1.5,     0.0,     0.0);      ( 266935.7, 1500081.1,     1.5,     0.0,     0.0);
( 266838.9, 1500196.0,     1.5,     0.0,     0.0);      ( 266731.6, 1500197.5,     1.5,     0.0,     0.0);
( 266849.5, 1499941.9,     1.5,     0.0,     0.0);      ( 266943.3, 1499845.1,     1.5,     0.0,     0.0);
( 266953.9, 1500504.5,     1.5,     0.0,     0.0);      ( 267094.5, 1500366.9,     1.5,     0.0,     0.0);
( 267263.9, 1500211.1,     1.5,     0.0,     0.0);      ( 266913.0, 1500837.2,     1.5,     0.0,     0.0);
( 266979.6, 1500673.9,     1.5,     0.0,     0.0);      ( 267093.0, 1500559.0,     1.5,     0.0,     0.0);
( 267204.9, 1500457.6,     1.5,     0.0,     0.0);      ( 267342.6, 1500335.1,     1.5,     0.0,     0.0);
( 267446.9, 1500230.8,     1.5,     0.0,     0.0);      ( 267430.3, 1500121.9,     1.5,     0.0,     0.0);
```

(266355.0,	1499790.7,	1.5,	0.0,	0.0);	(266321.7,	1499677.2,	1.5,	0.0,	0.0);
(266280.9,	1499559.3,	1.5,	0.0,	0.0);	(266224.9,	1499379.3,	1.5,	0.0,	0.0);
(266197.7,	1499264.4,	1.5,	0.0,	0.0);	(266172.0,	1499184.2,	1.5,	0.0,	0.0);
(266149.3,	1499085.9,	1.5,	0.0,	0.0);	(266126.1,	1499016.9,	1.5,	0.0,	0.0);
(266220.4,	1498975.5,	1.5,	0.0,	0.0);	(266338.3,	1498972.5,	1.5,	0.0,	0.0);
(266498.6,	1498963.4,	1.5,	0.0,	0.0);	(266640.8,	1498961.9,	1.5,	0.0,	0.0);
(266770.9,	1498951.3,	1.5,	0.0,	0.0);	(266899.7,	1498964.3,	1.5,	0.0,	0.0);
(266912.5,	1499076.7,	1.5,	0.0,	0.0);	(266912.5,	1499189.9,	1.5,	0.0,	0.0);
(266899.7,	1499302.3,	1.5,	0.0,	0.0);	(266891.9,	1499415.6,	1.5,	0.0,	0.0);
(266336.8,	1499276.5,	1.5,	0.0,	0.0);	(266336.8,	1499203.9,	1.5,	0.0,	0.0);
(266355.0,	1499098.0,	1.5,	0.0,	0.0);	(266288.4,	1499096.5,	1.5,	0.0,	0.0);
(266426.1,	1499270.4,	1.5,	0.0,	0.0);	(266429.1,	1499191.8,	1.5,	0.0,	0.0);
(266426.1,	1499120.7,	1.5,	0.0,	0.0);	(266424.5,	1499036.0,	1.5,	0.0,	0.0);
(266494.1,	1499337.0,	1.5,	0.0,	0.0);	(266563.7,	1499285.5,	1.5,	0.0,	0.0);
(266495.6,	1499188.7,	1.5,	0.0,	0.0);	(266604.5,	1499184.2,	1.5,	0.0,	0.0);
(266492.6,	1499111.6,	1.5,	0.0,	0.0);	(266607.5,	1499098.0,	1.5,	0.0,	0.0);
(266494.1,	1499039.0,	1.5,	0.0,	0.0);	(266528.9,	1499424.7,	1.5,	0.0,	0.0);
(266613.6,	1499507.9,	1.5,	0.0,	0.0);	(266525.9,	1499568.4,	1.5,	0.0,	0.0);
(266618.1,	1499574.4,	1.5,	0.0,	0.0);	(266565.2,	1499642.5,	1.5,	0.0,	0.0);
(266569.7,	1499712.0,	1.5,	0.0,	0.0);	(266581.8,	1499795.2,	1.5,	0.0,	0.0);
(266713.4,	1499780.1,	1.5,	0.0,	0.0);	(266840.4,	1499771.0,	1.5,	0.0,	0.0);
(266944.8,	1499781.6,	1.5,	0.0,	0.0);	(267056.7,	1499774.0,	1.5,	0.0,	0.0);
(267141.4,	1499692.4,	1.5,	0.0,	0.0);	(267021.9,	1499695.4,	1.5,	0.0,	0.0);
(266829.9,	1499704.5,	1.5,	0.0,	0.0);	(266730.0,	1499696.9,	1.5,	0.0,	0.0);
(266734.6,	1499591.0,	1.5,	0.0,	0.0);	(266727.0,	1499439.8,	1.5,	0.0,	0.0);
(266672.6,	1499352.1,	1.5,	0.0,	0.0);	(266708.9,	1499284.0,	1.5,	0.0,	0.0);
(266787.5,	1499202.4,	1.5,	0.0,	0.0);	(266843.5,	1499290.1,	1.5,	0.0,	0.0);
(266769.4,	1499355.1,	1.5,	0.0,	0.0);	(266825.3,	1499439.8,	1.5,	0.0,	0.0);
(266838.9,	1499577.4,	1.5,	0.0,	0.0);	(266935.7,	1499591.0,	1.5,	0.0,	0.0);
(267038.6,	1499580.5,	1.5,	0.0,	0.0);	(267131.1,	1499597.5,	1.5,	0.0,	0.0);
(267108.1,	1499477.6,	1.5,	0.0,	0.0);	(267214.0,	1499520.0,	1.5,	0.0,	0.0);
(267268.5,	1499601.6,	1.5,	0.0,	0.0);	(267283.6,	1499524.5,	1.5,	0.0,	0.0);

*** AERMOD - VERSION 11103 *** *** Title One *** 10/22/13
*** *** 18:11:05
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**MODELOPTs: RegDFAULT CONC ELEV

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZHILL, ZFLAG)
(METERS)

(267304.7,	1499275.0,	1.5,	0.0,	0.0);	(267276.0,	1499343.0,	1.5,	0.0,	0.0);
(267186.8,	1499222.0,	1.5,	0.0,	0.0);	(267298.7,	1499199.3,	1.5,	0.0,	0.0);
(267300.2,	1499120.7,	1.5,	0.0,	0.0);	(267406.1,	1499231.1,	1.5,	0.0,	0.0);
(267448.4,	1499578.9,	1.5,	0.0,	0.0);	(267442.4,	1499701.4,	1.5,	0.0,	0.0);

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( 267557.3, 1499491.2,   1.5,   0.0,   0.0);   ( 267753.9, 1499506.3,   1.5,   0.0,   0.0);
( 267785.7, 1499713.5,   1.5,   0.0,   0.0);   ( 267974.7, 1499837.6,   1.5,   0.0,   0.0);
( 267394.0, 1499860.2,   1.5,   0.0,   0.0);   ( 265129.5, 1497351.0,   1.5,   0.0,   0.0);
( 265777.7, 1497489.9,   1.5,   0.0,   0.0);   ( 265810.8, 1497327.9,   1.5,   0.0,   0.0);
( 265896.8, 1497523.0,   1.5,   0.0,   0.0);   ( 266290.4, 1497797.5,   1.5,   0.0,   0.0);
( 266293.7, 1497592.4,   1.5,   0.0,   0.0);   ( 266336.7, 1498015.8,   1.5,   0.0,   0.0);
( 266078.7, 1498128.2,   1.5,   0.0,   0.0);   ( 265679.1, 1498120.2,   1.5,   0.0,   0.0);
( 265616.9, 1498312.6,   1.5,   0.0,   0.0);   ( 265834.0, 1498280.4,   1.5,   0.0,   0.0);
( 265996.0, 1498227.4,   1.5,   0.0,   0.0);   ( 265853.8, 1498141.4,   1.5,   0.0,   0.0);
( 266330.1, 1498204.3,   1.5,   0.0,   0.0);   ( 266333.4, 1498429.2,   1.5,   0.0,   0.0);
( 266283.8, 1498647.5,   1.5,   0.0,   0.0);   ( 266108.5, 1498829.4,   1.5,   0.0,   0.0);
( 265939.8, 1498885.6,   1.5,   0.0,   0.0);   ( 266627.7, 1498214.2,   1.5,   0.0,   0.0);
( 266769.9, 1498177.8,   1.5,   0.0,   0.0);   ( 267014.7, 1498105.1,   1.5,   0.0,   0.0);
( 267269.3, 1498085.2,   1.5,   0.0,   0.0);   ( 267156.9, 1497635.4,   1.5,   0.0,   0.0);
( 264933.1, 1497222.7,   1.5,   0.0,   0.0);   ( 264861.6, 1497036.2,   1.5,   0.0,   0.0);
( 265147.4, 1496877.4,   1.5,   0.0,   0.0);   ( 264849.7, 1495928.9,   1.5,   0.0,   0.0);
( 264431.3, 1495337.1,   1.5,   0.0,   0.0);   ( 265250.6, 1495278.0,   1.5,   0.0,   0.0);
( 265949.1, 1496230.5,   1.5,   0.0,   0.0);   ( 266528.5, 1496524.2,   1.5,   0.0,   0.0);
( 267036.5, 1495750.3,   1.5,   0.0,   0.0);   ( 266881.7, 1495631.2,   1.5,   0.0,   0.0);
( 266500.7, 1495460.6,   1.5,   0.0,   0.0);   ( 267508.8, 1496099.5,   1.5,   0.0,   0.0);
( 267155.6, 1497107.6,   1.5,   0.0,   0.0);   ( 267909.6, 1496508.3,   1.5,   0.0,   0.0);
( 268123.9, 1497492.6,   1.5,   0.0,   0.0);   ( 268048.5, 1498103.7,   1.5,   0.0,   0.0);
( 267770.7, 1498822.1,   1.5,   0.0,   0.0);   ( 268826.4, 1498667.3,   1.5,   0.0,   0.0);
( 268084.3, 1499425.3,   1.5,   0.0,   0.0);   ( 267996.9, 1500310.4,   1.5,   0.0,   0.0);
( 268346.2, 1500326.3,   1.5,   0.0,   0.0);   ( 268258.9, 1500552.5,   1.5,   0.0,   0.0);
( 268532.7, 1500524.7,   1.5,   0.0,   0.0);   ( 268231.1, 1500806.5,   1.5,   0.0,   0.0);
( 268374.0, 1501147.8,   1.5,   0.0,   0.0);   ( 268727.2, 1501195.4,   1.5,   0.0,   0.0);
( 269009.0, 1500707.3,   1.5,   0.0,   0.0);   ( 269715.4, 1500433.4,   1.5,   0.0,   0.0);
( 269409.8, 1501393.8,   1.5,   0.0,   0.0);   ( 269421.7, 1499596.0,   1.5,   0.0,   0.0);
( 270441.7, 1501262.9,   1.5,   0.0,   0.0);   ( 270834.6, 1501564.5,   1.5,   0.0,   0.0);
( 271183.9, 1502064.6,   1.5,   0.0,   0.0);   ( 271374.4, 1502314.6,   1.5,   0.0,   0.0);
( 270648.1, 1502719.4,   1.5,   0.0,   0.0);   ( 270469.5, 1502382.1,   1.5,   0.0,   0.0);
( 270334.5, 1502663.8,   1.5,   0.0,   0.0);   ( 270056.7, 1502794.8,   1.5,   0.0,   0.0);
( 269878.1, 1502183.6,   1.5,   0.0,   0.0);   ( 269985.3, 1501850.3,   1.5,   0.0,   0.0);
( 270017.0, 1501524.8,   1.5,   0.0,   0.0);   ( 263873.4, 1495817.7,   1.5,   0.0,   0.0);
( 265381.5, 1496516.2,   1.5,   0.0,   0.0);   ( 268151.7, 1499080.1,   1.5,   0.0,   0.0);
( 268421.6, 1499667.4,   1.5,   0.0,   0.0);   ( 268892.8, 1503220.9,   1.5,   0.0,   0.0);
( 268926.1, 1503225.6,   1.5,   0.0,   0.0);   ( 268945.9, 1503225.6,   1.5,   0.0,   0.0);
( 268880.9, 1503203.4,   1.5,   0.0,   0.0);   ( 268987.2, 1503234.4,   1.5,   0.0,   0.0);
( 269009.5, 1503239.9,   1.5,   0.0,   0.0);   ( 269032.5, 1503245.5,   1.5,   0.0,   0.0);
( 268890.4, 1503176.4,   1.5,   0.0,   0.0);   ( 268924.5, 1503183.6,   1.5,   0.0,   0.0);

*** AERMOD - VERSION  11103 ***   *** Title One                              ***     10/22/13
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**MODELOPTs:  RegDFAULT CONC                           ELEV
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*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZHILL, ZFLAG)
(METERS)

```
( 268945.2, 1503188.3,   1.5,   0.0,   0.0);   ( 268962.6, 1503191.5,   1.5,   0.0,   0.0);
( 268978.5, 1503193.1,   1.5,   0.0,   0.0);   ( 269013.4, 1503197.9,   1.5,   0.0,   0.0);
( 269035.6, 1503200.2,   1.5,   0.0,   0.0);   ( 269088.8, 1503239.9,   1.5,   0.0,   0.0);
( 269080.9, 1503211.3,   1.5,   0.0,   0.0);   ( 269118.2, 1503244.7,   1.5,   0.0,   0.0);
( 268426.6, 1502991.4,   1.5,   0.0,   0.0);   ( 268488.5, 1502974.4,   1.5,   0.0,   0.0);
( 268249.1, 1502784.1,   1.5,   0.0,   0.0);   ( 268484.0, 1503014.1,   1.5,   0.0,   0.0);
( 268461.8, 1502992.8,   1.5,   0.0,   0.0);   ( 268344.3, 1502903.9,   1.5,   0.0,   0.0);
( 268465.7, 1502913.5,   1.5,   0.0,   0.0);   ( 268356.2, 1502800.7,   1.5,   0.0,   0.0);
( 268154.2, 1502515.6,   1.5,   0.0,   0.0);   ( 268173.3, 1502487.6,   1.5,   0.0,   0.0);
( 267907.1, 1502333.7,   1.5,   0.0,   0.0);   ( 267924.2, 1502384.1,   1.5,   0.0,   0.0);
( 267967.8, 1502410.3,   1.5,   0.0,   0.0);   ( 267847.0, 1502253.3,   1.5,   0.0,   0.0);
( 267794.0, 1502065.3,   1.5,   0.0,   0.0);   ( 267804.0, 1502103.6,   1.5,   0.0,   0.0);
( 267697.9, 1502102.5,   1.5,   0.0,   0.0);   ( 267469.5, 1501825.0,   1.5,   0.0,   0.0);
( 267431.8, 1501756.0,   1.5,   0.0,   0.0);   ( 267293.1, 1501548.5,   1.5,   0.0,   0.0);
( 267321.7, 1501542.1,   1.5,   0.0,   0.0);   ( 267324.1, 1501512.2,   1.5,   0.0,   0.0);
( 267202.5, 1501398.7,   1.5,   0.0,   0.0);   ( 267221.3, 1501417.1,   1.5,   0.0,   0.0);
( 267234.7, 1501434.7,   1.5,   0.0,   0.0);   ( 267267.6, 1501400.1,   1.5,   0.0,   0.0);
( 267246.1, 1501367.7,   1.5,   0.0,   0.0);   ( 267234.8, 1501335.9,   1.5,   0.0,   0.0);
( 267166.7, 1501315.7,   1.5,   0.0,   0.0);   ( 267161.4, 1501294.2,   1.5,   0.0,   0.0);
( 267143.6, 1501261.5,   1.5,   0.0,   0.0);   ( 267137.9, 1501242.0,   1.5,   0.0,   0.0);
( 267212.0, 1501300.2,   1.5,   0.0,   0.0);   ( 267208.7, 1501283.7,   1.5,   0.0,   0.0);
( 267198.5, 1501265.1,   1.5,   0.0,   0.0);   ( 267243.8, 1501286.6,   1.5,   0.0,   0.0);
( 267254.7, 1501321.4,   1.5,   0.0,   0.0);   ( 267276.8, 1501361.4,   1.5,   0.0,   0.0);
( 267288.1, 1501387.8,   1.5,   0.0,   0.0);   ( 266962.3, 1500919.6,   1.5,   0.0,   0.0);
( 266972.7, 1500932.7,   1.5,   0.0,   0.0);   ( 266995.3, 1500977.5,   1.5,   0.0,   0.0);
( 266924.2, 1500849.7,   1.5,   0.0,   0.0);   ( 266966.7, 1500810.6,   1.5,   0.0,   0.0);
( 266917.9, 1500801.0,   1.5,   0.0,   0.0);   ( 266948.5, 1500784.4,   1.5,   0.0,   0.0);
( 266904.0, 1500769.3,   1.5,   0.0,   0.0);   ( 266925.0, 1500752.2,   1.5,   0.0,   0.0);
( 266894.5, 1500716.5,   1.5,   0.0,   0.0);   ( 266883.4, 1500677.2,   1.5,   0.0,   0.0);
( 266863.9, 1500686.0,   1.5,   0.0,   0.0);   ( 266889.5, 1500634.8,   1.5,   0.0,   0.0);
( 266913.7, 1500657.4,   1.5,   0.0,   0.0);   ( 266926.8, 1500684.0,   1.5,   0.0,   0.0);
( 266950.6, 1500709.4,   1.5,   0.0,   0.0);   ( 266969.3, 1500736.0,   1.5,   0.0,   0.0);
( 266999.1, 1500751.4,   1.5,   0.0,   0.0);   ( 266815.3, 1500645.0,   1.5,   0.0,   0.0);
( 266805.8, 1500624.8,   1.5,   0.0,   0.0);   ( 266802.6, 1500614.0,   1.5,   0.0,   0.0);
( 266801.4, 1500593.8,   1.5,   0.0,   0.0);   ( 266879.2, 1500613.6,   1.5,   0.0,   0.0);
( 266812.9, 1500527.3,   1.5,   0.0,   0.0);   ( 266792.7, 1500515.4,   1.5,   0.0,   0.0);
( 266717.7, 1500371.4,   1.5,   0.0,   0.0);   ( 266745.1, 1500395.2,   1.5,   0.0,   0.0);
( 266665.7, 1500254.3,   1.5,   0.0,   0.0);   ( 266766.1, 1500374.1,   1.5,   0.0,   0.0);
( 266827.2, 1500392.7,   1.5,   0.0,   0.0);   ( 266755.6, 1500272.2,   1.5,   0.0,   0.0);
( 266814.7, 1500317.4,   1.5,   0.0,   0.0);   ( 266605.8, 1500142.1,   1.5,   0.0,   0.0);
( 266643.9, 1500119.9,   1.5,   0.0,   0.0);   ( 266683.9, 1500097.6,   1.5,   0.0,   0.0);
( 266575.2, 1500087.3,   1.5,   0.0,   0.0);   ( 266542.3, 1500061.2,   1.5,   0.0,   0.0);
```

(265932.6, 1499069.3, 1.5, 0.0, 0.0); (265976.9, 1499018.3, 1.5, 0.0, 0.0);
(265962.3, 1499112.6, 1.5, 0.0, 0.0); (265979.2, 1499114.9, 1.5, 0.0, 0.0);
(266008.0, 1499171.5, 1.5, 0.0, 0.0); (266042.5, 1498993.6, 1.5, 0.0, 0.0);

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZHILL, ZFLAG)
(METERS)

(266077.3, 1499032.3, 1.5, 0.0, 0.0); (266113.3, 1499061.1, 1.5, 0.0, 0.0);
(265963.5, 1498972.1, 1.5, 0.0, 0.0); (265993.3, 1498924.8, 1.5, 0.0, 0.0);
(266135.7, 1499035.2, 1.5, 0.0, 0.0); (266144.7, 1499054.2, 1.5, 0.0, 0.0);
(266161.6, 1499098.1, 1.5, 0.0, 0.0); (266167.9, 1499116.1, 1.5, 0.0, 0.0);
(266167.9, 1499135.7, 1.5, 0.0, 0.0); (266167.9, 1499157.9, 1.5, 0.0, 0.0);
(266184.9, 1499199.7, 1.5, 0.0, 0.0); (266187.0, 1499216.2, 1.5, 0.0, 0.0);
(266193.3, 1499236.3, 1.5, 0.0, 0.0); (266187.5, 1498981.2, 1.5, 0.0, 0.0);
(266184.9, 1499020.4, 1.5, 0.0, 0.0); (266211.9, 1499017.7, 1.5, 0.0, 0.0);
(266100.2, 1498928.3, 1.5, 0.0, 0.0); (265843.8, 1498878.8, 1.5, 0.0, 0.0);
(265890.9, 1498893.0, 1.5, 0.0, 0.0); (265915.3, 1498841.2, 1.5, 0.0, 0.0);
(265965.0, 1498850.7, 1.5, 0.0, 0.0); (266004.2, 1498859.7, 1.5, 0.0, 0.0);
(265961.3, 1498797.8, 1.5, 0.0, 0.0); (265772.4, 1498748.3, 1.5, 0.0, 0.0);
(265702.5, 1498609.1, 1.5, 0.0, 0.0); (265634.8, 1498360.4, 1.5, 0.0, 0.0);
(265748.1, 1498283.7, 1.5, 0.0, 0.0); (265760.8, 1498301.1, 1.5, 0.0, 0.0);
(265845.9, 1498341.9, 1.5, 0.0, 0.0); (265815.0, 1498191.9, 1.5, 0.0, 0.0);
(265821.9, 1498261.7, 1.5, 0.0, 0.0); (265612.3, 1498191.9, 1.5, 0.0, 0.0);
(265642.5, 1498108.1, 1.5, 0.0, 0.0); (265721.7, 1497974.6, 1.5, 0.0, 0.0);
(265584.1, 1498253.8, 1.5, 0.0, 0.0); (265638.7, 1498332.6, 1.5, 0.0, 0.0);
(265580.0, 1498198.5, 1.5, 0.0, 0.0); (268887.7, 1502568.8, 1.5, 0.0, 0.0);
(268911.1, 1503084.6, 1.5, 0.0, 0.0); (268902.8, 1503067.1, 1.5, 0.0, 0.0);
(268910.7, 1503038.9, 1.5, 0.0, 0.0); (268909.5, 1503025.0, 1.5, 0.0, 0.0);
(268968.7, 1503082.6, 1.5, 0.0, 0.0); (268987.3, 1503087.0, 1.5, 0.0, 0.0);
(269003.6, 1503088.9, 1.5, 0.0, 0.0); (269013.7, 1503173.1, 1.5, 0.0, 0.0);
(269055.5, 1503179.4, 1.5, 0.0, 0.0); (269094.9, 1503164.9, 1.5, 0.0, 0.0);
(269103.1, 1503147.2, 1.5, 0.0, 0.0); (269116.8, 1503119.7, 1.5, 0.0, 0.0);
(269159.9, 1503189.4, 1.5, 0.0, 0.0); (265685.6, 1497684.3, 1.5, 0.0, 0.0);

```
*** AERMOD - VERSION  11103 ***   *** Title One                                  ***       10/22/13
                   ***                                          ***       18:11:05
                                                                    PAGE   9
**MODELOPTs:  RegDFAULT CONC                             ELEV


                        *** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
                                  (1=YES; 0=NO)

      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1

        NOTE:  METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.



                   *** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
                                 (METERS/SEC)

                             1.54,   3.09,   5.14,   8.23,  10.80,

*** AERMOD - VERSION  11103 ***   *** Title One                                  ***       10/22/13
                   ***                                          ***       18:11:05
                                                                    PAGE  10
**MODELOPTs:  RegDFAULT CONC                             ELEV


                    *** UP TO THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

 Surface file:   PGUMA_08.SFC                                        Met Version:  12345
 Profile file:   PGUMA_08.PFL
 Surface format: FREE
 Profile format: FREE
 Surface station no.:    41415            Upper air station no.:    99999
          Name: UNKNOWN                           Name: UNKNOWN
          Year:   2008                         Year:   2008

First 24 hours of scalar data
YR MO DY JDY HR     H0     U*     W*  DT/DZ ZICNV ZIMCH  M-O LEN    Z0  BOWEN ALBEDO  REF WS   WD     HT  REF TA     HT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
08 01 01   1 01  -39.6  0.376 -9.000 -9.000 -999.  531.    120.0  0.43   0.80   1.00    3.36   91.   10.0  299.1    2.0
```

```
08 01 01   1 02  -39.4  0.375 -9.000 -9.000 -999.  528.    119.0  0.42   0.91   1.00    3.36   78.   10.0  299.1    2.0
08 01 01   1 03  -30.4  0.302 -9.000 -9.000 -999.  385.     81.1  0.42   0.91   1.00    2.86   84.   10.0  299.1    2.0
08 01 01   1 04  -30.4  0.302 -9.000 -9.000 -999.  382.     81.0  0.42   0.91   1.00    2.86   83.   10.0  298.8    2.0
08 01 01   1 05  -39.4  0.375 -9.000 -9.000 -999.  528.    119.0  0.42   0.91   1.00    3.36   63.   10.0  299.1    2.0
08 01 01   1 06  -50.2  0.803 -9.000 -9.000 -999. 1654.    917.7  0.42   0.91   1.00    6.46   62.   10.0  299.1    2.0
08 01 01   1 07  -24.9  0.396 -9.000 -9.000 -999.  766.    223.1  0.42   0.91   1.00    3.36   65.   10.0  298.1    2.0
08 01 01   1 08    6.8  0.368  0.318  0.006  169.  521.   -654.2  0.42   0.91   0.39    2.86   83.   10.0  299.1    2.0
08 01 01   1 09   41.7  0.579  0.793  0.006  426. 1014.   -415.8  0.46   0.94   0.23    4.36   47.   10.0  300.1    2.0
08 01 01   1 10  135.9  0.708  1.397  0.005  717. 1368.   -233.2  0.42   0.91   0.18    5.36   81.   10.0  301.4    2.0
08 01 01   1 11   92.7  0.581  1.272  0.006  794. 1035.   -189.0  0.42   0.91   0.17    4.36   74.   10.0  300.9    2.0
08 01 01   1 12  191.2  0.661  1.708  0.005  932. 1235.   -135.1  0.43   0.80   0.15    4.86  116.   10.0  300.4    2.0
08 01 01   1 13  200.7  0.447  1.812  0.006 1058.  728.    -39.7  0.48   0.82   0.15    2.86  143.   10.0  300.4    2.0
08 01 01   1 14  189.0  0.603  1.835  0.006 1168. 1076.   -103.2  0.43   0.80   0.15    4.36   99.   10.0  302.0    2.0
08 01 01   1 15   89.5  0.772  1.450  0.005 1214. 1556.   -457.2  0.42   0.91   0.17    5.96   72.   10.0  301.4    2.0
08 01 01   1 16  119.5  0.780  1.623  0.005 1276. 1582.   -352.8  0.43   0.80   0.18    5.96   94.   10.0  302.0    2.0
08 01 01   1 17   66.4  0.694  1.345  0.005 1306. 1341.   -449.0  0.42   0.91   0.24    5.36   71.   10.0  301.4    2.0
08 01 01   1 18  -10.0  0.674 -9.000 -9.000 -999. 1273.   2711.2  0.42   0.91   0.46    5.36   67.   10.0  300.9    2.0
08 01 01   1 19  -51.8  0.517 -9.000 -9.000 -999.  877.    237.3  0.42   0.91   1.00    4.36   64.   10.0  299.9    2.0
08 01 01   1 20  -39.0  0.387 -9.000 -9.000 -999.  568.    133.0  0.46   0.94   1.00    3.36   47.   10.0  298.8    2.0
08 01 01   1 21  -38.0  0.377 -9.000 -9.000 -999.  533.    126.1  0.42   0.91   1.00    3.36   60.   10.0  298.8    2.0
08 01 01   1 22  -38.0  0.377 -9.000 -9.000 -999.  533.    126.1  0.42   0.91   1.00    3.36   62.   10.0  298.8    2.0
08 01 01   1 23  -39.1  0.387 -9.000 -9.000 -999.  554.    132.7  0.46   0.94   1.00    3.36   50.   10.0  298.1    2.0
08 01 01   1 24  -46.3  0.460 -9.000 -9.000 -999.  716.    187.1  0.46   0.94   1.00    3.86   50.   10.0  298.8    2.0


First hour of profile data
YR MO DY HR HEIGHT F  WDIR    WSPD AMB_TMP sigmaA  sigmaW  sigmaV
08 01 01 01   10.0 1   91.    3.36   299.2   99.0  -99.00  -99.00

F indicates top of profile (=1) or below (=0)

*** AERMOD - VERSION  11103 ***   *** Title One                                  ***       10/22/13
                        ***                                            ***      18:11:05
                                                                           PAGE  11
**MODELOPTs:  RegDFAULT CONC                                ELEV


                    *** THE   1ST HIGHEST 24-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                       INCLUDING SOURCE(S):     FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

                               *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                           ** CONC OF PM2.5_24 IN MICROGRAMS/M**3                    **

   X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)           X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     269137.79   1503231.37       0.13024b (08100524)           268963.81   1503220.43       0.19260b (08100524)
```

268956.15	1503088.03	0.20203b (08100524)	268928.80	1502939.22	0.19327b (08100524)
268990.07	1503033.32	0.19338b (08100524)	269001.01	1502967.67	0.18754b (08100524)
268987.88	1502896.55	0.18242b (08100524)	269083.08	1502946.88	0.17593b (08100524)
269062.29	1503059.58	0.18060b (08100524)	269040.40	1503140.55	0.17979b (08100524)
269127.94	1503104.44	0.16100b (08100524)	269205.63	1503107.73	0.13984b (08100524)
269165.14	1502985.18	0.16419b (08100524)	269226.42	1502992.84	0.15253b (08100524)
269325.99	1503030.04	0.12549b (08100524)	269436.50	1503063.96	0.09128b (08100524)
269329.27	1503306.87	0.07851b (08082824)	269507.62	1503004.87	0.08950b (08100524)
269562.33	1502944.69	0.09157b (08100524)	269143.26	1502813.39	0.16197b (08100524)
269226.42	1502805.73	0.15489b (08100524)	269290.97	1502803.54	0.14912b (08100524)
269129.03	1502625.19	0.14785b (08100524)	269199.06	1502620.81	0.14409b (08100524)
269266.90	1502621.91	0.14108b (08100524)	269331.46	1502619.72	0.13805b (08100524)
269390.54	1502616.44	0.13512b (08100524)	269124.66	1502510.30	0.14113b (08100524)
269297.54	1502507.02	0.13275b (08100524)	269456.20	1502609.87	0.13152b (08100524)
268509.72	1502801.35	0.24159b (08100524)	268297.45	1502698.50	0.28849b (08100524)
268149.74	1502373.53	0.20931c (08100624)	268224.14	1502379.00	0.19841c (08100624)
268309.49	1502426.05	0.19315c (08100624)	268232.89	1502486.23	0.22136c (08100624)
268448.45	1502403.07	0.16598c (08100624)	268507.54	1502414.01	0.15894b (08100524)
268642.12	1502412.92	0.15570b (08100524)	268653.06	1502178.76	0.11825c (08100624)
268487.84	1502055.12	0.12347c (08100624)	268144.27	1502117.49	0.15312c (08100624)
268325.90	1502097.79	0.13872c (08100624)	267976.85	1502035.42	0.20546b (08072324)
268360.91	1501905.21	0.11105c (08100624)	268596.16	1501813.30	0.09336c (08100624)
267848.83	1501400.79	0.15346b (08072324)	267916.67	1501430.34	0.13637b (08072324)
267758.02	1501477.39	0.19108b (08072324)	268064.39	1501517.87	0.10122b (08072324)
268177.09	1501540.85	0.08213c (08100624)	268156.30	1501732.33	0.09509c (08100624)
268247.12	1501618.54	0.08390c (08100624)	268366.39	1501711.54	0.09070c (08100624)
267976.85	1501340.61	0.11031b (08072324)	267836.80	1501782.67	0.21471b (08072324)
267531.52	1501510.21	0.23125b (08072324)	267358.64	1501583.52	0.21990b (08072324)
267194.51	1501382.19	0.16640b (08072324)	267348.79	1501343.90	0.19965b (08072324)
267307.21	1501296.85	0.19022b (08072324)	267151.84	1501274.96	0.15353b (08072324)
267260.16	1501246.51	0.17906b (08072324)	267428.67	1501121.78	0.18098b (08072324)
267330.19	1501103.18	0.17886b (08072324)	267417.73	1501216.97	0.19170b (08072324)
267586.23	1501052.84	0.16357b (08072324)	267617.96	1500922.63	0.14761b (08072324)
267682.52	1501041.90	0.15248b (08072324)	267591.70	1500780.39	0.13658b (08072324)
267919.96	1501113.02	0.10638b (08072324)	267748.17	1500956.55	0.13314b (08072324)
267895.88	1500945.61	0.09986b (08072324)	267756.92	1500824.16	0.12034b (08072324)
267739.42	1500679.72	0.11241b (08072324)	267600.45	1500593.28	0.12094b (08072324)
267623.43	1500446.66	0.10905b (08072324)	267750.36	1500524.35	0.10036b (08072324)
267951.69	1500502.47	0.06771b (08072324)	267958.25	1500587.81	0.06973b (08072324)

*** AERMOD - VERSION 11103 *** *** Title One *** 10/22/13
*** *** 18:11:05
PAGE 12
**MODELOPTs: RegDFAULT CONC ELEV

*** THE 1ST HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***

INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
267957.16	1500789.14	0.07828b (08072324)	268006.40	1500975.16	0.07825b (08072324)
268078.61	1501148.04	0.07547c (08082124)	268086.27	1501214.78	0.07614c (08082124)
267976.85	1501178.67	0.09732b (08072324)	266829.86	1500692.06	0.08537b (08072324)
266782.98	1500604.34	0.08122b (08072324)	266441.18	1499950.99	0.06998b (08070824)
266497.14	1500094.67	0.06803b (08083124)	266607.54	1500106.77	0.06996b (08072324)
266554.61	1499981.24	0.06741b (08072324)	266557.63	1499876.88	0.07367b (08070824)
266639.30	1499860.25	0.07328b (08070824)	266649.89	1500034.17	0.07149b (08072324)
266595.44	1500218.68	0.06995b (08072324)	266690.72	1500351.77	0.07466b (08072324)
266746.68	1500465.20	0.07819b (08072324)	266929.68	1500286.74	0.09702b (08072324)
267065.79	1500127.94	0.11053b (08072324)	267156.54	1500032.66	0.10894b (08072324)
267040.08	1499958.55	0.10285b (08072324)	266935.73	1500081.05	0.09600b (08072324)
266838.94	1500196.00	0.08525b (08072324)	266731.56	1500197.51	0.07631b (08072324)
266849.52	1499941.92	0.08551b (08072324)	266943.29	1499845.12	0.09285b (08072324)
266953.88	1500504.52	0.10187b (08072324)	267094.53	1500366.90	0.12151b (08072324)
267263.92	1500211.12	0.11544b (08072324)	266913.04	1500837.25	0.09570b (08072324)
266979.59	1500673.91	0.10721b (08072324)	267093.02	1500558.97	0.12732b (08072324)
267204.93	1500457.64	0.13221b (08072324)	267342.56	1500335.14	0.11844b (08072324)
267446.91	1500230.78	0.10484b (08072324)	267430.28	1500121.89	0.09931b (08072324)
266354.97	1499790.68	0.08291b (08070824)	266321.70	1499677.25	0.09432b (08070824)
266280.87	1499559.28	0.10927b (08070824)	266224.91	1499379.31	0.11923b (08070824)
266197.69	1499264.37	0.11511b (08070824)	266171.98	1499184.21	0.11510b (08070824)
266149.29	1499085.91	0.10980b (08070824)	266126.15	1499016.94	0.11365b (08100524)
266220.37	1498975.50	0.08899b (08100524)	266338.34	1498972.48	0.06150b (08072324)
266498.65	1498963.40	0.06527b (08072324)	266640.81	1498961.89	0.06896b (08072324)
266770.88	1498951.31	0.07044b (08072324)	266899.68	1498964.29	0.06933b (08072324)
266912.46	1499076.72	0.07213b (08072324)	266912.46	1499189.87	0.07519b (08072324)
266899.68	1499302.29	0.07807b (08072324)	266891.87	1499415.61	0.08064b (08072324)
266336.82	1499276.47	0.08662b (08070824)	266336.82	1499203.87	0.08531b (08070824)
266354.97	1499098.01	0.07698b (08070824)	266288.43	1499096.49	0.08708b (08070824)
266426.06	1499270.42	0.07445b (08070824)	266429.08	1499191.77	0.07274b (08070824)
266426.06	1499120.69	0.06872b (08070824)	266424.54	1499036.00	0.06323b (08072324)
266494.11	1499336.96	0.06748b (08070824)	266563.68	1499285.54	0.06643b (08072324)
266495.63	1499188.75	0.06440b (08072324)	266604.52	1499184.21	0.06807b (08072324)
266492.60	1499111.62	0.06465b (08072324)	266607.54	1499098.01	0.06826b (08072324)
266494.11	1499039.02	0.06499b (08072324)	266528.90	1499424.68	0.06609b (08070824)
266613.59	1499507.86	0.06856b (08072324)	266525.87	1499568.36	0.07696b (08070824)
266618.13	1499574.41	0.06888b (08072324)	266565.19	1499642.46	0.07755b (08070824)
266569.73	1499712.03	0.07997b (08070824)	266581.83	1499795.21	0.07771b (08070824)
266713.41	1499780.09	0.07431b (08072324)	266840.45	1499771.02	0.08346b (08072324)

266944.80	1499781.60	0.09158b (08072324)	267056.72	1499774.04	0.09645b (08072324)

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*** AERMOD - VERSION  11103 ***   *** Title One                                   ***       10/22/13
                    ***                                         ***       18:11:05
                                                                   PAGE  13
**MODELOPTs:  RegDFAULT CONC                              ELEV


                 *** THE   1ST HIGHEST 24-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL     ***
                   INCLUDING SOURCE(S):     FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

                          *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                       ** CONC OF PM2.5_24 IN MICROGRAMS/M**3                   **
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X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
267141.41	1499692.37	0.09212b (08072324)	267021.93	1499695.40	0.09265b (08072324)
266829.86	1499704.47	0.08206b (08072324)	266730.04	1499696.91	0.07514b (08072324)
266734.58	1499591.04	0.07504b (08072324)	266727.02	1499439.80	0.07390b (08072324)
266672.57	1499352.09	0.07096b (08072324)	266708.87	1499284.03	0.07227b (08072324)
266787.51	1499202.36	0.07413b (08072324)	266843.47	1499290.08	0.07680b (08072324)
266769.37	1499355.11	0.07526b (08072324)	266825.32	1499439.80	0.07865b (08072324)
266838.94	1499577.43	0.08123b (08072324)	266935.73	1499591.04	0.08644b (08072324)
267038.57	1499580.46	0.08849b (08072324)	267131.10	1499597.49	0.08795b (08072324)
267108.14	1499477.61	0.08321b (08072324)	267214.01	1499519.96	0.08091b (08072324)
267268.45	1499601.63	0.08183b (08072324)	267283.58	1499524.50	0.07754b (08072324)
267304.75	1499274.96	0.06648b (08072324)	267276.01	1499343.01	0.07036b (08072324)
267186.78	1499222.02	0.06965b (08072324)	267298.70	1499199.34	0.06403b (08072324)
267300.21	1499120.69	0.06130b (08072324)	267406.08	1499231.10	0.06120b (08072324)
267448.43	1499578.94	0.07235b (08072324)	267442.38	1499701.45	0.07768b (08072324)
267557.32	1499491.23	0.06600b (08072324)	267753.93	1499506.35	0.05983b (08072324)
267785.69	1499713.55	0.06278b (08072324)	267974.74	1499837.56	0.05402c (08082124)
267393.98	1499860.25	0.08730b (08072324)	265129.51	1497351.00	0.14339b (08072324)
265777.74	1497489.91	0.05329b (08072324)	265810.81	1497327.85	0.05087b (08072324)
265896.80	1497522.98	0.04687b (08072324)	266290.37	1497797.49	0.05796c (08062224)
266293.68	1497592.44	0.05119b (08072324)	266336.68	1498015.77	0.07827b (08100524)
266078.71	1498128.22	0.08084b (08100524)	265679.05	1498120.15	0.11465c (08100624)
265616.87	1498312.63	0.17324c (08100624)	265833.97	1498280.36	0.10316c (08100624)
265996.02	1498227.44	0.09547b (08100524)	265853.81	1498141.45	0.08756c (08100624)
266330.06	1498204.29	0.09951b (08100524)	266333.37	1498429.18	0.11710b (08100524)
266283.76	1498647.47	0.12707b (08100524)	266108.47	1498829.37	0.15063b (08100524)
265939.80	1498885.59	0.18923b (08100524)	266627.72	1498214.21	0.09834b (08100524)
266769.93	1498177.83	0.09222b (08100524)	267014.67	1498105.07	0.07889b (08100524)
267269.33	1498085.23	0.06209b (08100524)	267156.89	1497635.43	0.05807b (08100524)
264933.06	1497222.68	0.10772b (08072324)	264861.62	1497036.15	0.08963b (08072324)
265147.37	1496877.40	0.09370b (08072324)	264849.71	1495928.87	0.05716b (08072324)

264431.28	1495337.12	0.04785b (08072324)	265250.56	1495277.99	0.06277b (08072324)
265949.06	1496230.49	0.04304b (08072324)	266528.50	1496524.18	0.02824b (08072324)
267036.50	1495750.27	0.01148b (08072324)	266881.72	1495631.21	0.00842b (08072324)
266500.72	1495460.55	0.01405b (08072324)	267508.78	1496099.52	0.02847b (08072324)
267155.56	1497107.59	0.03858c (08062224)	267909.63	1496508.31	0.03268b (08072324)
268123.94	1497492.56	0.03876b (08100524)	268048.53	1498103.75	0.03599b (08072324)
267770.72	1498822.09	0.04942b (08072324)	268826.41	1498667.31	0.03302c (08100624)
268084.25	1499425.34	0.05142c (08082124)	267996.94	1500310.38	0.06395c (08082124)
268346.19	1500326.25	0.05246c (08100624)	268258.88	1500552.47	0.05742c (08082124)
268532.72	1500524.69	0.04762c (08100624)	268231.10	1500806.47	0.06182c (08100624)

*** THE 1ST HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
268373.97	1501147.78	0.06180c (08100624)	268727.19	1501195.41	0.05047c (08100624)
269008.97	1500707.25	0.02898c (08100624)	269715.41	1500433.41	0.03928c (08062224)
269409.82	1501393.85	0.08486c (08062224)	269421.72	1499596.00	0.01063c (08100624)
270441.69	1501262.88	0.07060b (08100524)	270834.60	1501564.50	0.07413b (08100524)
271183.85	1502064.57	0.02287b (08100524)	271374.35	1502314.60	0.01851b (08070824)
270648.07	1502719.41	0.04328b (08070824)	270469.48	1502382.07	0.05154b (08100524)
270334.54	1502663.85	0.04191b (08070824)	270056.72	1502794.82	0.04281b (08070824)
269878.13	1502183.63	0.10245b (08100524)	269985.29	1501850.25	0.09279b (08100524)
270017.04	1501524.82	0.07895b (08100524)	263873.40	1495817.74	0.06058b (08083124)
265381.53	1496516.24	0.07756b (08072324)	268151.72	1499080.06	0.04844c (08082124)
268421.60	1499667.44	0.04526c (08100624)	268892.77	1503220.87	0.21905b (08100524)
268926.11	1503225.63	0.20588b (08100524)	268945.95	1503225.63	0.19836b (08100524)
268880.86	1503203.41	0.22400b (08100524)	268987.22	1503234.36	0.18136b (08100524)
269009.45	1503239.92	0.17209b (08100524)	269032.47	1503245.48	0.16254b (08100524)
268890.39	1503176.42	0.22080b (08100524)	268924.52	1503183.56	0.21044b (08100524)
268945.16	1503188.33	0.20348b (08100524)	268962.62	1503191.50	0.19735b (08100524)
268978.49	1503193.09	0.19180b (08100524)	269013.42	1503197.85	0.17924b (08100524)
269035.64	1503200.23	0.17135b (08100524)	269088.83	1503239.92	0.14433b (08100524)
269080.89	1503211.34	0.15404b (08100524)	269118.19	1503244.68	0.13300b (08100524)
268426.57	1502991.37	0.36101b (08100524)	268488.48	1502974.44	0.30491b (08100524)
268249.05	1502784.08	0.36478b (08100524)	268483.99	1503014.12	0.32773b (08100524)

268461.78	1502992.83	0.33266b (08100524)	268344.30	1502903.93	0.37482b (08100524)
268465.75	1502913.46	0.29382b (08100524)	268356.21	1502800.75	0.30742b (08100524)
268154.24	1502515.63	0.25116c (08100624)	268173.29	1502487.59	0.23657c (08100624)
267907.12	1502333.71	0.35546b (08072324)	267924.19	1502384.11	0.37272b (08072324)
267967.85	1502410.30	0.34756b (08072324)	267846.98	1502253.34	0.35804b (08072324)
267794.03	1502065.30	0.30991b (08072324)	267804.01	1502103.62	0.31820b (08072324)
267697.93	1502102.50	0.38944b (08072324)	267469.51	1501824.98	0.27709b (08072324)
267431.83	1501755.98	0.25561b (08072324)	267293.11	1501548.47	0.20010b (08072324)
267321.69	1501542.12	0.20785b (08072324)	267324.07	1501512.22	0.20674b (08072324)
267202.52	1501398.68	0.16893b (08072324)	267221.25	1501417.10	0.17472b (08072324)
267234.74	1501434.72	0.17907b (08072324)	267267.58	1501400.08	0.18710b (08072324)
267246.08	1501367.67	0.18041b (08072324)	267234.84	1501335.92	0.17654b (08072324)
267166.71	1501315.74	0.15796b (08072324)	267161.41	1501294.25	0.15630b (08072324)
267143.56	1501261.50	0.15118b (08072324)	267137.93	1501241.99	0.14947b (08072324)
267212.02	1501300.20	0.16972b (08072324)	267208.71	1501283.66	0.16850b (08072324)
267198.46	1501265.14	0.16550b (08072324)	267243.77	1501286.64	0.17715b (08072324)
267254.68	1501321.37	0.18095b (08072324)	267276.84	1501361.38	0.18774b (08072324)
267288.08	1501387.84	0.19154b (08072324)	266962.35	1500919.56	0.10441b (08072324)
266972.67	1500932.65	0.10650b (08072324)	266995.29	1500977.50	0.11145b (08072324)

*** THE 1ST HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
266924.25	1500849.71	0.09747b (08072324)	266966.71	1500810.57	0.10494b (08072324)
266917.90	1500801.05	0.09631b (08072324)	266948.46	1500784.38	0.10141b (08072324)
266904.01	1500769.30	0.09415b (08072324)	266925.04	1500752.23	0.09732b (08072324)
266894.48	1500716.52	0.09267b (08072324)	266883.37	1500677.22	0.09111b (08072324)
266863.92	1500685.96	0.08878b (08072324)	266889.52	1500634.76	0.09184b (08072324)
266913.73	1500657.38	0.09537b (08072324)	266926.83	1500683.97	0.09750b (08072324)
266950.64	1500709.37	0.10169b (08072324)	266969.29	1500735.96	0.10530b (08072324)
266999.06	1500751.44	0.11150b (08072324)	266815.31	1500645.00	0.08389b (08072324)
266805.78	1500624.76	0.08301b (08072324)	266802.61	1500614.04	0.08271b (08072324)
266801.42	1500593.80	0.08253b (08072324)	266879.20	1500613.65	0.09044b (08072324)
266812.92	1500527.28	0.08321b (08072324)	266792.68	1500515.38	0.08152b (08072324)
266717.67	1500371.39	0.07611b (08072324)	266745.06	1500395.20	0.07778b (08072324)

266665.68	1500254.31	0.07305b (08072324)	266766.09	1500374.09	0.07908b (08072324)
266827.21	1500392.74	0.08426b (08072324)	266755.58	1500272.17	0.07807b (08072324)
266814.71	1500317.42	0.08294b (08072324)	266605.76	1500142.08	0.07003b (08072324)
266643.86	1500119.85	0.07153b (08072324)	266683.94	1500097.63	0.07334b (08072324)
266575.20	1500087.31	0.06860b (08072324)	266542.26	1500061.19	0.06720b (08072324)
265932.57	1499069.26	0.20882b (08100524)	265976.88	1499018.32	0.18665b (08100524)
265962.33	1499112.58	0.18217b (08070824)	265979.20	1499114.90	0.17322b (08070824)
266007.97	1499171.45	0.17641b (08070824)	266042.53	1498993.58	0.16269b (08100524)
266077.26	1499032.28	0.13413b (08100524)	266113.31	1499061.05	0.11373b (08070824)
265963.49	1498972.09	0.19011b (08100524)	265993.25	1498924.79	0.17797b (08100524)
266135.67	1499035.18	0.10565b (08070824)	266144.66	1499054.23	0.10659b (08070824)
266161.60	1499098.15	0.10884b (08070824)	266167.95	1499116.14	0.10956b (08070824)
266167.95	1499135.72	0.11155b (08070824)	266167.95	1499157.94	0.11371b (08070824)
266184.88	1499199.75	0.11314b (08070824)	266187.00	1499216.15	0.11389b (08070824)
266193.35	1499236.26	0.11386b (08070824)	266187.53	1498981.20	0.10208b (08100524)
266184.88	1499020.36	0.09458b (08070824)	266211.87	1499017.71	0.08946b (08070824)
266100.21	1498928.29	0.15106b (08100524)	265843.83	1498878.76	0.22472b (08100524)
265890.93	1498893.04	0.20635b (08100524)	265915.27	1498841.18	0.19103b (08100524)
265965.01	1498850.71	0.17911b (08100524)	266004.17	1498859.71	0.17106b (08100524)
265961.31	1498797.79	0.17499b (08100524)	265772.39	1498748.26	0.23227b (08100524)
265702.54	1498609.09	0.22408b (08100524)	265634.81	1498360.38	0.17830c (08100624)
265748.05	1498283.65	0.12413c (08100624)	265760.75	1498301.12	0.12307c (08100624)
265845.95	1498341.86	0.11625b (08100524)	265814.99	1498191.90	0.09893c (08100624)
265821.87	1498261.75	0.10415c (08100624)	265612.32	1498191.90	0.14443c (08100624)
265642.48	1498108.08	0.12047c (08100624)	265721.68	1497974.62	0.08734c (08100624)
265584.10	1498253.76	0.17019c (08100624)	265638.73	1498332.60	0.16908c (08100624)
265580.00	1498198.46	0.15738c (08100624)	268887.72	1502568.80	0.15983b (08100524)
268911.13	1503084.58	0.21077b (08100524)	268902.80	1503067.12	0.21084b (08100524)

*** AERMOD - VERSION 11103 *** *** Title One *** 10/22/13
*** *** 18:11:05
PAGE 16
**MODELOPTs: RegDFAULT CONC ELEV

*** THE 1ST HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
268910.73	1503038.94	0.20675b (08100524)	268909.54	1503025.05	0.20551b (08100524)
268968.68	1503082.60	0.19932b (08100524)	268987.33	1503086.96	0.19563b (08100524)
269003.60	1503088.95	0.19222b (08100524)	269013.66	1503173.08	0.18330b (08100524)

269055.46	1503179.43	0.16898b (08100524)	269094.88	1503164.93	0.15961b (08100524)
269103.09	1503147.21	0.16058b (08100524)	269116.84	1503119.69	0.16153b (08100524)
269159.92	1503189.44	0.13441b (08100524)	265685.65	1497684.29	0.06447c (08100624)

*** AERMOD - VERSION 11103 *** *** Title One *** 10/22/13
*** *** 18:11:05
PAGE 17
**MODELOPTs: RegDFAULT CONC ELEV

*** THE 2ND HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
269137.79	1503231.37	0.08740b (08082824)	268963.81	1503220.43	0.10029b (08082824)
268956.15	1503088.03	0.09801c (08062224)	268928.80	1502939.22	0.09528c (08062224)
268990.07	1503033.32	0.08455c (08062224)	269001.01	1502967.67	0.08209c (08062224)
268987.88	1502896.55	0.08536c (08062224)	269083.08	1502946.88	0.06815c (08100624)
269062.29	1503059.58	0.07729b (08082824)	269040.40	1503140.55	0.08590b (08082824)
269127.94	1503104.44	0.07763b (08082824)	269205.63	1503107.73	0.07403b (08082824)
269165.14	1502985.18	0.06629b (08082824)	269226.42	1502992.84	0.06454b (08082824)
269325.99	1503030.04	0.06361b (08082824)	269436.50	1503063.96	0.06203b (08082824)
269329.27	1503306.87	0.07130b (08082324)	269507.62	1503004.87	0.05646b (08082824)
269562.33	1502944.69	0.05174b (08082824)	269143.26	1502813.39	0.06692c (08100624)
269226.42	1502805.73	0.05893c (08100624)	269290.97	1502803.54	0.05238c (08100624)
269129.03	1502625.19	0.07665c (08062224)	269199.06	1502620.81	0.07017c (08062224)
269266.90	1502621.91	0.06302c (08062224)	269331.46	1502619.72	0.05702c (08100624)
269390.54	1502616.44	0.05258c (08100624)	269124.66	1502510.30	0.07975c (08062224)
269297.54	1502507.02	0.06523c (08062224)	269456.20	1502609.87	0.04761c (08100624)
268509.72	1502801.35	0.20624c (08100624)	268297.45	1502698.50	0.25792c (08100624)
268149.74	1502373.53	0.20184b (08072324)	268224.14	1502379.00	0.16064b (08072324)
268309.49	1502426.05	0.16604b (08100524)	268232.89	1502486.23	0.20099b (08100524)
268448.45	1502403.07	0.15555b (08100524)	268507.54	1502414.01	0.15755c (08100624)
268642.12	1502412.92	0.13626c (08100624)	268653.06	1502178.76	0.09895b (08100524)
268487.84	1502055.12	0.09633c (08062224)	268144.27	1502117.49	0.14655b (08072324)
268325.90	1502097.79	0.09299c (08062224)	267976.85	1502035.42	0.14362c (08100624)
268360.91	1501905.21	0.06730c (08062224)	268596.16	1501813.30	0.07672c (08062224)
267848.83	1501400.79	0.09376c (08082124)	267916.67	1501430.34	0.09320c (08082124)
267758.02	1501477.39	0.09161c (08082124)	268064.39	1501517.87	0.08650c (08100624)
268177.09	1501540.85	0.07534c (08082124)	268156.30	1501732.33	0.09270b (08072324)
268247.12	1501618.54	0.07106c (08082124)	268366.39	1501711.54	0.06243c (08082124)
267976.85	1501340.61	0.08672c (08082124)	267836.80	1501782.67	0.11423c (08082124)

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     267531.52   1501510.21      0.09125b (08091624)         267358.64   1501583.52      0.11597b (08083124)
     267194.51   1501382.19      0.11469b (08083124)         267348.79   1501343.90      0.09529b (08091624)
     267307.21   1501296.85      0.09333b (08091624)         267151.84   1501274.96      0.10579b (08083124)
     267260.16   1501246.51      0.09055b (08091624)         267428.67   1501121.78      0.07447b (08091624)
     267330.19   1501103.18      0.08290b (08091624)         267417.73   1501216.97      0.08226b (08091624)
     267586.23   1501052.84      0.04965b (08091624)         267617.96   1500922.63      0.04474c (08082124)
     267682.52   1501041.90      0.05783c (08082124)         267591.70   1500780.39      0.03841b (08070824)
     267919.96   1501113.02      0.08277c (08082124)         267748.17   1500956.55      0.06431c (08082124)
     267895.88   1500945.61      0.07742c (08082124)         267756.92   1500824.16      0.06052c (08082124)
     267739.42   1500679.72      0.05336c (08082124)         267600.45   1500593.28      0.04380b (08070824)
     267623.43   1500446.66      0.04422b (08070824)         267750.36   1500524.35      0.05018c (08082124)
     267951.69   1500502.47      0.06707c (08082124)         267958.25   1500587.81      0.06916c (08082124)

*** AERMOD - VERSION  11103 ***   *** Title One                                  ***       10/22/13
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**MODELOPTs:  RegDFAULT CONC                                   ELEV


                 *** THE   2ND HIGHEST 24-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                   INCLUDING SOURCE(S):     FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

                        *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                      ** CONC OF PM2.5_24 IN MICROGRAMS/M**3                     **

   X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)            X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     267957.16   1500789.14      0.07380c (08082124)         268006.40   1500975.16      0.07652c (08082124)
     268078.61   1501148.04      0.07328c (08100624)         268086.27   1501214.78      0.07508c (08100624)
     267976.85   1501178.67      0.08254c (08082124)         266829.86   1500692.06      0.08266b (08083124)
     266782.98   1500604.34      0.07997b (08083124)         266441.18   1499950.99      0.06527b (08070524)
     266497.14   1500094.67      0.06537b (08072324)         266607.54   1500106.77      0.06113b (08083124)
     266554.61   1499981.24      0.06737b (08070824)         266557.63   1499876.88      0.06718b (08072324)
     266639.30   1499860.25      0.07050b (08072324)         266649.89   1500034.17      0.06396b (08070824)
     266595.44   1500218.68      0.06891b (08083124)         266690.72   1500351.77      0.06998b (08083124)
     266746.68   1500465.20      0.07300b (08083124)         266929.68   1500286.74      0.06657b (08091624)
     267065.79   1500127.94      0.06257b (08091624)         267156.54   1500032.66      0.05403b (08091624)
     267040.08   1499958.55      0.06107b (08091624)         266935.73   1500081.05      0.06636b (08091624)
     266838.94   1500196.00      0.06388b (08091624)         266731.56   1500197.51      0.05949c (08100224)
     266849.52   1499941.92      0.06659b (08091624)         266943.29   1499845.12      0.06447b (08091624)
     266953.88   1500504.52      0.06744b (08091624)         267094.53   1500366.90      0.06623b (08091624)
     267263.92   1500211.12      0.05180b (08070824)         266913.04   1500837.25      0.08702b (08083124)
     266979.59   1500673.91      0.06872b (08091624)         267093.02   1500558.97      0.07086b (08091624)
     267204.93   1500457.64      0.06226b (08091624)         267342.56   1500335.14      0.04999b (08070824)
     267446.91   1500230.78      0.04459b (08070824)         267430.28   1500121.89      0.03993b (08070824)
     266354.97   1499790.68      0.07616b (08070524)         266321.70   1499677.25      0.08385b (08070524)
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266280.87	1499559.28	0.08850b (08070524)	266224.91	1499379.31	0.08191b (08070524)
266197.69	1499264.37	0.07462b (08070624)	266171.98	1499184.21	0.07055b (08082824)
266149.29	1499085.91	0.07405b (08082824)	266126.15	1499016.94	0.10480b (08070824)
266220.37	1498975.50	0.08075b (08070824)	266338.34	1498972.48	0.06104b (08070824)
266498.65	1498963.40	0.05563b (08091624)	266640.81	1498961.89	0.05259b (08091624)
266770.88	1498951.31	0.04555b (08091624)	266899.68	1498964.29	0.03718b (08091624)
266912.46	1499076.72	0.04105b (08091624)	266912.46	1499189.87	0.04619b (08091624)
266899.68	1499302.29	0.05231b (08091624)	266891.87	1499415.61	0.05766b (08091624)
266336.82	1499276.47	0.06161b (08091624)	266336.82	1499203.87	0.06024b (08091624)
266354.97	1499098.01	0.06124b (08072324)	266288.43	1499096.49	0.06137b (08082824)
266426.06	1499270.42	0.06269b (08091624)	266429.08	1499191.77	0.06246b (08072324)
266426.06	1499120.69	0.06282b (08072324)	266424.54	1499036.00	0.05883b (08070824)
266494.11	1499336.96	0.06459b (08091624)	266563.68	1499285.54	0.06440b (08091624)
266495.63	1499188.75	0.06405b (08070824)	266604.52	1499184.21	0.06133b (08091624)
266492.60	1499111.62	0.05975b (08091624)	266607.54	1499098.01	0.05843b (08091624)
266494.11	1499039.02	0.05778b (08091624)	266528.90	1499424.68	0.06544b (08091624)
266613.59	1499507.86	0.06666b (08091624)	266525.87	1499568.36	0.06517b (08072324)
266618.13	1499574.41	0.06609b (08091624)	266565.19	1499642.46	0.06680b (08072324)
266569.73	1499712.03	0.06716b (08072324)	266581.83	1499795.21	0.06786b (08072324)
266713.41	1499780.09	0.07007b (08070824)	266840.45	1499771.02	0.06686b (08091624)
266944.80	1499781.60	0.06355b (08091624)	267056.72	1499774.04	0.05613b (08091624)

*** AERMOD - VERSION 11103 *** *** Title One *** 10/22/13
*** *** 18:11:05
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**MODELOPTs: RegDFAULT CONC ELEV

*** THE 2ND HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
267141.41	1499692.37	0.04694b (08091624)	267021.93	1499695.40	0.05687b (08091624)
266829.86	1499704.47	0.06677b (08091624)	266730.04	1499696.91	0.06704b (08091624)
266734.58	1499591.04	0.06746b (08091624)	266727.02	1499439.80	0.06612b (08091624)
266672.57	1499352.09	0.06524b (08091624)	266708.87	1499284.03	0.06222b (08091624)
266787.51	1499202.36	0.05532b (08091624)	266843.47	1499290.08	0.05570b (08091624)
266769.37	1499355.11	0.06238b (08091624)	266825.32	1499439.80	0.06250b (08091624)
266838.94	1499577.43	0.06512b (08091624)	266935.73	1499591.04	0.06030b (08091624)
267038.57	1499580.46	0.05230b (08091624)	267131.10	1499597.49	0.04495b (08091624)
267108.14	1499477.61	0.04267b (08091624)	267214.01	1499519.96	0.03518b (08091624)
267268.45	1499601.63	0.03332b (08091624)	267283.58	1499524.50	0.02972b (08091624)

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     267304.75  1499274.96       0.02004b (08091624)            267276.01  1499343.01       0.02414b (08091624)
     267186.78  1499222.02       0.02603b (08091624)            267298.70  1499199.34       0.02136b (08082324)
     267300.21  1499120.69       0.02324b (08082324)            267406.08  1499231.10       0.02031c (08032124)
     267448.43  1499578.94       0.02225c (08032124)            267442.38  1499701.45       0.02297b (08091624)
     267557.32  1499491.23       0.02299c (08032124)            267753.93  1499506.35       0.03027c (08082124)
     267785.69  1499713.55       0.03618c (08082124)            267974.74  1499837.56       0.05164b (08072324)
     267393.98  1499860.25       0.03202c (08062224)            265129.51  1497351.00       0.06405b (08091624)
     265777.74  1497489.91       0.04978c (08100624)            265810.81  1497327.85       0.04465c (08100624)
     265896.80  1497522.98       0.03964c (08100624)            266290.37  1497797.49       0.05274b (08072324)
     266293.68  1497592.44       0.04636c (08062224)            266336.68  1498015.77       0.06039c (08062224)
     266078.71  1498128.22       0.07231c (08062224)            265679.05  1498120.15       0.07131b (08072324)
     265616.87  1498312.63       0.12076b (08100524)            265833.97  1498280.36       0.10109b (08100524)
     265996.02  1498227.44       0.07904c (08062224)            265853.81  1498141.45       0.07892c (08062224)
     266330.06  1498204.29       0.06078c (08062224)            266333.37  1498429.18       0.05855b (08072324)
     266283.76  1498647.47       0.05899b (08072324)            266108.47  1498829.37       0.07457c (08062224)
     265939.80  1498885.59       0.13710c (08062224)            266627.72  1498214.21       0.05783b (08072324)
     266769.93  1498177.83       0.05189b (08072324)            267014.67  1498105.07       0.04050b (08072324)
     267269.33  1498085.23       0.03612b (08072324)            267156.89  1497635.43       0.02832b (08072324)
     264933.06  1497222.68       0.07246c (08100224)            264861.62  1497036.15       0.06675c (08100224)
     265147.37  1496877.40       0.03752b (08022824)            264849.71  1495928.87       0.02967b (08091624)
     264431.28  1495337.12       0.03574c (08090824)            265250.56  1495277.99       0.02741c (08090824)
     265949.06  1496230.49       0.03250c (08100624)            266528.50  1496524.18       0.01408  (08010624)
     267036.50  1495750.27       0.01028c (08032124)            266881.72  1495631.21       0.00825c (08032124)
     266500.72  1495460.55       0.00972b (08091724)            267508.78  1496099.52       0.01852c (08062224)
     267155.56  1497107.59       0.02168b (08072324)            267909.63  1496508.31       0.02646c (08062224)
     268123.94  1497492.56       0.03201c (08082124)            268048.53  1498103.75       0.03573c (08082124)
     267770.72  1498822.09       0.02333c (08082124)            268826.41  1498667.31       0.03107c (08032224)
     268084.25  1499425.34       0.04133b (08072324)            267996.94  1500310.38       0.05752b (08072324)
     268346.19  1500326.25       0.05132c (08082124)            268258.88  1500552.47       0.05737c (08100624)
     268532.72  1500524.69       0.04224c (08032224)            268231.10  1500806.47       0.06117c (08082124)

*** AERMOD - VERSION  11103 ***   *** Title One                                   ***        10/22/13
                     ***                                          ***       18:11:05
                                                                             PAGE  20
**MODELOPTs:  RegDFAULT CONC                                ELEV


                    *** THE   2ND HIGHEST 24-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                       INCLUDING SOURCE(S):     FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

                              *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                           ** CONC OF PM2.5_24 IN MICROGRAMS/M**3                      **

   X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)            X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     268373.97  1501147.78       0.05526c (08082124)            268727.19  1501195.41       0.04121c (08062224)
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269008.97	1500707.25	0.02720c (08062224)	269715.41	1500433.41	0.01683c (08100624)
269409.82	1501393.85	0.04147c (08100624)	269421.72	1499596.00	0.00698b (08081924)
270441.69	1501262.88	0.04893c (08062224)	270834.60	1501564.50	0.01744c (08100624)
271183.85	1502064.57	0.01655c (08062224)	271374.35	1502314.60	0.01839b (08082824)
270648.07	1502719.41	0.03217b (08082824)	270469.48	1502382.07	0.03351b (08070824)
270334.54	1502663.85	0.03140b (08082824)	270056.72	1502794.82	0.03811b (08082824)
269878.13	1502183.63	0.03707c (08100624)	269985.29	1501850.25	0.05566c (08062224)
270017.04	1501524.82	0.07041c (08062224)	263873.40	1495817.74	0.05396c (08090724)
265381.53	1496516.24	0.03073c (08082124)	268151.72	1499080.06	0.03568b (08072324)
268421.60	1499667.44	0.04509c (08082124)	268892.77	1503220.87	0.13278c (08062224)
268926.11	1503225.63	0.11520c (08062224)	268945.95	1503225.63	0.10487c (08062224)
268880.86	1503203.41	0.13846c (08062224)	268987.22	1503234.36	0.09971b (08082824)
269009.45	1503239.92	0.09828b (08082824)	269032.47	1503245.48	0.09681b (08082824)
268890.39	1503176.42	0.13213c (08062224)	268924.52	1503183.56	0.11554c (08062224)
268945.16	1503188.33	0.10552c (08062224)	268962.62	1503191.50	0.09703b (08082824)
268978.49	1503193.09	0.09584b (08082824)	269013.42	1503197.85	0.09349b (08082824)
269035.64	1503200.23	0.09200b (08082824)	269088.83	1503239.92	0.09167b (08082824)
269080.89	1503211.34	0.08971b (08082824)	269118.19	1503244.68	0.08985b (08082824)
268426.57	1502991.37	0.29997c (08062224)	268488.48	1502974.44	0.25206c (08100624)
268249.05	1502784.08	0.31968c (08100624)	268483.99	1503014.12	0.27258c (08062224)
268461.78	1502992.83	0.27487c (08062224)	268344.30	1502903.93	0.31586c (08100624)
268465.75	1502913.46	0.24625c (08100624)	268356.21	1502800.75	0.26394c (08100624)
268154.24	1502515.63	0.24669b (08072324)	268173.29	1502487.59	0.22264b (08072324)
267907.12	1502333.71	0.25927c (08100624)	267924.19	1502384.11	0.27927c (08100624)
267967.85	1502410.30	0.27236c (08100624)	267846.98	1502253.34	0.23741c (08100624)
267794.03	1502065.30	0.14649c (08100624)	267804.01	1502103.62	0.15765c (08100624)
267697.93	1502102.50	0.16293b (08022824)	267469.51	1501824.98	0.14427b (08083124)
267431.83	1501755.98	0.13689b (08083124)	267293.11	1501548.47	0.12521b (08083124)
267321.69	1501542.12	0.11714b (08083124)	267324.07	1501512.22	0.11024b (08083124)
267202.52	1501398.68	0.11594b (08083124)	267221.25	1501417.10	0.11566b (08083124)
267234.74	1501434.72	0.11612b (08083124)	267267.58	1501400.08	0.10291b (08083124)
267246.08	1501367.67	0.10218b (08083124)	267234.84	1501335.92	0.09929b (08083124)
267166.71	1501315.74	0.10925b (08083124)	267161.41	1501294.25	0.10699b (08083124)
267143.56	1501261.50	0.10522b (08083124)	267137.93	1501241.99	0.10341b (08083124)
267212.02	1501300.20	0.09838b (08083124)	267208.71	1501283.66	0.09643b (08083124)
267198.46	1501265.14	0.09567b (08083124)	267243.77	1501286.64	0.09077b (08091624)
267254.68	1501321.37	0.09218b (08091624)	267276.84	1501361.38	0.09449b (08091624)
267288.08	1501387.84	0.09585b (08091624)	266962.35	1500919.56	0.08946b (08083124)
266972.67	1500932.65	0.08957b (08083124)	266995.29	1500977.50	0.09148b (08083124)

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*** *** 18:11:05
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**MODELOPTs: RegDFAULT CONC ELEV

*** THE 2ND HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***

INCLUDING SOURCE(S): FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF PM2.5_24 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC (YYMMDDHH)
266924.25	1500849.71	0.08699b (08083124)	266966.71	1500810.57	0.07782b (08083124)
266917.90	1500801.05	0.08318b (08083124)	266948.46	1500784.38	0.07769b (08083124)
266904.01	1500769.30	0.08182b (08083124)	266925.04	1500752.23	0.07765b (08083124)
266894.48	1500716.52	0.07810b (08083124)	266883.37	1500677.22	0.07584b (08083124)
266863.92	1500685.96	0.07885b (08083124)	266889.52	1500634.76	0.07112b (08083124)
266913.73	1500657.38	0.06994b (08083124)	266926.83	1500683.97	0.07068b (08083124)
266950.64	1500709.37	0.06970b (08083124)	266969.29	1500735.96	0.07011c (08100224)
266999.06	1500751.44	0.07037c (08100224)	266815.31	1500645.00	0.08029b (08083124)
266805.78	1500624.76	0.07958b (08083124)	266802.61	1500614.04	0.07904b (08083124)
266801.42	1500593.80	0.07760b (08083124)	266879.20	1500613.65	0.07052b (08083124)
266812.92	1500527.28	0.07107b (08083124)	266792.68	1500515.38	0.07232b (08083124)
266717.67	1500371.39	0.06892b (08083124)	266745.06	1500395.20	0.06796b (08083124)
266665.68	1500254.31	0.06560b (08083124)	266766.09	1500374.09	0.06397b (08083124)
266827.21	1500392.74	0.06297c (08100224)	266755.58	1500272.17	0.06066c (08100224)
266814.71	1500317.42	0.06156c (08100224)	266605.76	1500142.08	0.06355b (08083124)
266643.86	1500119.85	0.05940b (08070824)	266683.94	1500097.63	0.06054b (08070824)
266575.20	1500087.31	0.06270b (08083124)	266542.26	1500061.19	0.06369b (08083124)
265932.57	1499069.26	0.18246b (08070824)	265976.88	1499018.32	0.14291b (08070824)
265962.33	1499112.58	0.17270b (08100524)	265979.20	1499114.90	0.15221b (08100524)
266007.97	1499171.45	0.10752b (08070624)	266042.53	1498993.58	0.11878b (08070824)
266077.26	1499032.28	0.11711b (08070824)	266113.31	1499061.05	0.08718b (08100524)
265963.49	1498972.09	0.13669b (08070824)	265993.25	1498924.79	0.11889b (08070824)
266135.67	1499035.18	0.09414b (08100524)	266144.66	1499054.23	0.07409b (08100524)
266161.60	1499098.15	0.07339b (08082824)	266167.95	1499116.14	0.07342b (08082824)
266167.95	1499135.72	0.07369b (08082824)	266167.95	1499157.94	0.07310b (08082824)
266184.88	1499199.75	0.06937b (08070624)	266187.00	1499216.15	0.07093b (08070624)
266193.35	1499236.26	0.07219b (08070624)	266187.53	1498981.20	0.08765b (08070824)
266184.88	1499020.36	0.07723b (08100524)	266211.87	1499017.71	0.06649b (08100524)
266100.21	1498928.29	0.09476b (08070824)	265843.83	1498878.76	0.19125c (08062224)
265890.93	1498893.04	0.16367c (08062224)	265915.27	1498841.18	0.14971c (08062224)
265965.01	1498850.71	0.12824c (08062224)	266004.17	1498859.71	0.11101c (08062224)
265961.31	1498797.79	0.13362c (08062224)	265772.39	1498748.26	0.20444c (08062224)
265702.54	1498609.09	0.21208c (08062224)	265634.81	1498360.38	0.14003b (08100524)
265748.05	1498283.65	0.09773b (08100524)	265760.75	1498301.12	0.10487b (08100524)
265845.95	1498341.86	0.10547c (08100624)	265814.99	1498191.90	0.08426c (08062224)
265821.87	1498261.75	0.09465b (08100524)	265612.32	1498191.90	0.09985b (08072324)
265642.48	1498108.08	0.07986b (08072324)	265721.68	1497974.62	0.06025b (08072324)
265584.10	1498253.76	0.13023b (08072324)	265638.73	1498332.60	0.12375b (08100524)
265580.00	1498198.46	0.12083b (08072324)	268887.72	1502568.80	0.10020c (08062224)

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     268911.13  1503084.58      0.11513c (08062224)          268902.80  1503067.12      0.11590c (08062224)

*** AERMOD - VERSION  11103 ***   *** Title One                                   ***       10/22/13
                    ***                                       ***      18:11:05
                                                                  PAGE  22
**MODELOPTs:  RegDFAULT CONC                               ELEV


                  *** THE   2ND HIGHEST 24-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL     ***
                    INCLUDING SOURCE(S):     FINEGAYAN_A , FINEGAYAN_B , S_FINEGAYAN ,

                           *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                        ** CONC OF PM2.5_24 IN MICROGRAMS/M**3                    **

    X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)           X-COORD (M)  Y-COORD (M)       CONC     (YYMMDDHH)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     268910.73  1503038.94      0.10950c (08062224)          268909.54  1503025.05      0.10796c (08062224)
     268968.68  1503082.60      0.09295c (08062224)          268987.33  1503086.96      0.08579c (08062224)
     269003.60  1503088.95      0.08337b (08082824)          269013.66  1503173.08      0.09094b (08082824)
     269055.46  1503179.43      0.08855b (08082824)          269094.88  1503164.93      0.08463b (08082824)
     269103.09  1503147.21      0.08260b (08082824)          269116.84  1503119.69      0.07949b (08082824)
     269159.92  1503189.44      0.08269b (08082824)          265685.65  1497684.29      0.06315b (08072324)

*** AERMOD - VERSION  11103 ***   *** Title One                                   ***       10/22/13
                    ***                                       ***      18:11:05
                                                                  PAGE  23
**MODELOPTs:  RegDFAULT CONC                               ELEV


                            *** THE SUMMARY OF HIGHEST 24-HR RESULTS ***


                      ** CONC OF PM2.5_24 IN MICROGRAMS/M**3                    **

                                 DATE                                     NETWORK
GROUP ID                   AVERAGE CONC     (YYMMDDHH)          RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL     HIGH   1ST HIGH VALUE IS      0.38944b ON 08072324: AT (  267697.93,  1502102.50,     1.52,     0.00,    0.00)  DC
       HIGH   2ND HIGH VALUE IS      0.31968c ON 08100624: AT (  268249.05,  1502784.08,     1.52,     0.00,    0.00)  DC


*** RECEPTOR TYPES:  GC = GRIDCART
               GP = GRIDPOLR
               DC = DISCCART
               DP = DISCPOLR
```

**MODELOPTs: RegDFAULT CONC ELEV

*** Message Summary : AERMOD Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 960 Informational Message(s)

A Total of 8784 Hours Were Processed

A Total of 821 Calm Hours Identified

A Total of 139 Missing Hours Identified (1.58 Percent)

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** AERMOD Finishes Successfully ***
****

On-road Mobile Source

Air Quality Impact Analysis

AIR QUALITY TECHNICAL REPORT
OFF-BASE ROADS COMPONENT

November 2013

Prepared for:

DEPARTMENT OF PUBLIC WORKS
GOVERNMENT OF GUAM

Prepared by:

PARSONS BRINCKERHOFF

Table of Contents

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1 INTRODUCTION

This technical report presents the results of the air quality impact assessment for the off-base roadway traffic associated with the Guam and CNMI Military Relocation (2012 Roadmap Adjustments).

Provided in this report is a description of the proposed project scenarios, an identification of air pollutants associated with motor vehicle exhaust, a review of applicable standards and regulations, and an evaluation of estimated local project-related air quality emissions. A description of the ambient air quality in the study area has been provided by others on the project team and is not presented in this technical report but can be found in the SEIS.

2 PROJECT DESCRIPTION

The Department of Defense (DoD), in a joint statement with the Government of Japan released on April 26, 2012, announced that they have agreed to adjustments in the 2006 Realignment Roadmap Agreement to relocate U.S. Marine Corps forces from Okinawa, Japan to Guam. The force adjustments would reduce the originally planned relocation of approximately 8,600 Marines with 9,000 dependents to a force of approximately 5,000 Marines with approximately 1,300 dependents.

As a consequence of this substantial change to the proposed action in the Guam and CNMI Military Relocation Final Environmental Impact Statement (FEIS) and Record of Decision (ROD) issued in 2010, a Supplemental Environmental Impact Statement (SEIS) is being prepared. The assessment will include an evaluation of alternatives for the associated infrastructure to support the relocation of a substantially reduced number of Marines and dependents than was previously analyzed. The main cantonment and family housing alternatives are:

- Finegayan/Finegayan
- Finegayan/South Finegayan
- Barrigada/Barrigada
- Andersen AFB/ Andersen AFB

The locations of the main alternatives for the live-fire training range complex (LFTRC) are:

- AAFB-North West Field
- Route 15
- Naval Base Guam Munitions Site (NBGMS)

This report provides an assessment of the potential air quality impacts from off-base roadway traffic for the following selected scenarios (combinations of main cantonment/family housing/LFTRC alternatives):

- No Build
- No Action (FEIS/ROD Proposed Action)
- Barrigada/LFTRC AAFB-NWF
- Barrigada/LFTRC Route 15
- Andersen AFB/ LFTRC NBGMS
- Finegayan/ LFTRC AAFB-NWF
- Finegayan/ LFTRC NBGMS
- Finegayan/South Finegayan- LFTRC NBGMS

The analysis years for each scenario are year 2030 (project year) and year 2021 (peak construction year).

A full description of the project alternatives and scenarios can be found in the SEIS.

3 REGULATORY SETTING

"Air Pollution" is a general term that refers to one or more chemical substances that degrade the quality of the atmosphere. Individual air pollutants degrade the atmosphere by reducing visibility, damaging property, reducing the productivity or vigor of crops or natural vegetation, and/or reducing human or animal health. Air quality is a term used to describe the amount of air pollution the public is exposed to.

Air quality in the United States is governed by the Federal Clean Air Act (CAA) and is administered by the United States Environmental Protection Agency (USEPA).

3.1 U.S. ENVIRONMENTAL PROTECTION AGENCY

The USEPA is responsible for establishing the National Ambient Air Quality Standards and enforcing the Clean Air Act, and regulates emission sources under the exclusive authority of the federal government, such as aircraft, ships, and certain types of locomotives.

3.2 CLEAN AIR ACT AMENDMENTS OF 1990

The Clean Air Act Amendments of 1990 (CAAA) and the Final Conformity Rule (40 CFR Parts 51 and 93) direct the EPA to implement environmental policies and regulations that will ensure acceptable levels of air quality.

The Clean Air Act and the Final Conformity Rule affect proposed transportation projects. According to Title I, Section 101, Paragraph F of the amendments:

> "No federal agency may approve, accept or fund any transportation plan, program or project unless such plan, program, or project has been found to conform to any applicable State Implementation Plan (SIP) in effect under this act."

The Final Transportation Conformity Rule defines conformity as follows:

> Conformity to an implementations plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards; and that such activities will not:

- cause or contribute to any new violation of any NAAQS in any area.
- increase the frequency or severity of any existing violation of any NAAQS in any area.
- delay timely attainment of any NAAQS or any required interim emission reductions or other milestones in any area.

The Conformity Rule only applies to areas that are classified as nonattainment (i.e. not meeting the ambient air quality standards). The majority of Guam is classified as attainment for all pollutants. Two locations however are near power plants, (Piti and Tanguisson) are classified as nonattainment for sulfur dioxide. If federal approval or funding for the proposed project would be required, compliance with the Conformity Rule would have to be demonstrated.

3.3 NATIONAL AND STATE AMBIENT AIR QUALITY STANDARDS

As required by the Clean Air Act, National Ambient Air Quality Standards have been established for six major air pollutants. These pollutants, known as criteria pollutants, are: carbon monoxide, nitrogen dioxide, ozone, particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide, and lead.

Guam has adopted the Federal standards as the standards for the Territory; these standards are summarized in Table 3-1. The "primary" standards have been established to protect the public health. The "secondary" standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation and other aspects of the general welfare.

3.3.1 Criteria Pollutants and Effects[1]

As previously discussed, pollutants that have established national standards are referred to as "criteria pollutants". The sources of these pollutants, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. A brief description of each pollutant is given below.

Ozone. O_3, a colorless toxic gas, enters the blood stream and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. O_3 also damages vegetation by inhibiting their growth. Although O_3 is not directly emitted, it forms in the atmosphere through a chemical reaction between volatile organic compounds (VOC) and nitrogen oxides (NO_x), which are emitted from industrial sources and from automobiles. Substantial O_3 formations generally require a stable atmosphere with strong sunlight.

Particulate Matter. Particulate pollution is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. In general, particulate pollution can include dust, soot, and smoke; these can be irritating but usually are not poisonous. Particulate pollution also can include bits of solid or liquid substances that can be highly toxic. Of particular concern are those particles that are smaller than, or equal to, 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$) in size.

PM_{10}. PM_{10} refers to particulate matter less than 10 microns in diameter, about one/seventh the thickness of a human hair (Figure 3-1). Particulate matter pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. Particulate matter also forms when industry and gases emitted from motor vehicles undergo chemical reactions in the atmosphere. Major sources of PM_{10} include motor vehicles; wood burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. Suspended particulates produce haze and reduce visibility. Additionally, PM_{10} poses a greater health risk than larger-sized particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract. PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections.

[1] American Lung Association: http://www.cleanairchoice.org/air/pollutants.cfm

Table 3-1: Guam and Federal Ambient Air Quality Standards

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	$0.15\ \mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	$PM_{2.5}$	primary	Annual	$12\ \mu g/m^3$	annual mean, averaged over 3 years
		secondary	Annual	$15\ \mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24-hour	$35\ \mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	$150\ \mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

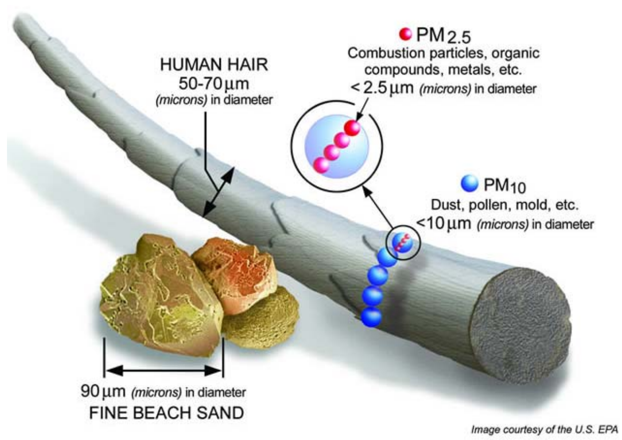
(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard (“anti-backsliding”). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Figure 3-1. Relative Particulate Matter Size



$PM_{2.5}$. A small portion of particulate matter is the product of fuel combustion processes. In the case of $PM_{2.5}$, the combustion of fossil fuels accounts for a significant portion of this pollutant. The main health effect of airborne particulate matter is on the respiratory system. $PM_{2.5}$ refers to particulates that are 2.5 microns or less in diameter, roughly 1/28th the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. In addition, $PM_{2.5}$ can be formed in the atmosphere *from* gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Like PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas, particles 2.5 to 10 microns in diameter tend to collect in the upper portion of the respiratory system, particles 2.5 microns or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues.

Carbon Monoxide. CO, a colorless gas, interferes with the transfer of oxygen to the brain. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, or heart disease. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban “street canyon” conditions. Consequently, CO concentrations must be predicted on a localized, or microscale, basis.

Nitrogen Dioxide. NO_2, a brownish gas, irritates the lungs. It can cause breathing difficulties at high concentrations. Like O_3, NO_2 is not directly emitted, but is formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NO and NO_2 are collectively referred to as nitrogen oxides (NO_x) and are major contributors to ozone formation. NO_2 also contributes to the formation of PM_{10}, small liquid and solid particles that are less than 10 microns in diameter (see discussion of PM_{10} below). At atmospheric concentration, NO_2 is only potentially irritating. In high concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between NO_2 and chronic pulmonary fibrosis. Some increase in bronchitis in children (two and three years old) has also been observed at concentrations below 0.3 parts per million (ppm).

Lead. Pb is a stable element that persists and accumulates both in the environment and in animals. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline.

Sulfur Dioxide. SO_2 is a product of high-sulfur fuel combustion. The main sources of SO_2 are coal and oil used in power stations, industry and for domestic heating. Industrial chemical manufacturing is another source of SO_2. SO_2 is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 can also yellow plant leaves and erode iron and steel.

3.4 MOBILE SOURCE AIR TOXICS [2]

In addition to the criteria pollutants for which there are NAAQS, the EPA also regulates air toxics. Toxic air pollutants are those pollutants known or suspected to cause cancer or other serious health effects. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments (CAAA) of 1990, whereby Congress mandated that the U.S. Environmental Protection Agency (EPA) regulate 188 air toxics, also known as hazardous air pollutants. The EPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS) (http://www.epa.gov/ncea/iris/index.html). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (NATA) (http://www.epa.gov/ttn/atw/nata1999/). These are acrolein, benzene, 1,3-butadiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

The 2007 EPA rule mentioned above requires controls that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. According to an FHWA analysis using EPA's MOVES2010b model, even if vehicle activity (vehicle-miles traveled, VMT) on a national basis increases by 102 percent as assumed from 2010 to 2050, a combined reduction of 83 percent in the total annual emissions for the priority MSAT is projected for the same period.

A brief description of the seven priority MSATs is given below.

Acrolein is a water-white or yellow liquid that burns easily, is readily volatilized, and has a disagreeable odor. It is present as a product of incomplete combustion in the exhausts of stationary equipment (e.g., boilers and heaters) and mobile sources. It is also a secondary pollutant, formed through the photochemical reaction of VOC and NOX in the atmosphere. Acrolein is considered to have high acute toxicity, and it causes upper respiratory tract irritation and congestion in humans. The major effects from chronic (long-term) inhalation exposure to acrolein in humans consist of general respiratory congestion and eye, nose, and throat irritation. No information is available on the reproductive, developmental, or carcinogenic effects of acrolein in humans. EPA considers acrolein data to be inadequate for an assessment of human carcinogenic potential.

Benzene is a volatile, colorless, highly flammable liquid with a sweet odor. Most of the benzene in ambient air is from incomplete combustion of fossil fuels and evaporation from gasoline service stations. Acute inhalation exposure to benzene causes neurological symptoms, such as drowsiness, dizziness, headaches, and unconsciousness in humans. Chronic inhalation of certain levels of benzene causes disorders in the blood in humans. Benzene specifically affects bone marrow (the tissues that produce blood cells). Aplastic anemia, excessive bleeding, and damage to the immune system (by changes in blood levels of antibodies and loss of white blood cells) may develop. Available human data on the developmental effects of benzene are inconclusive due to concomitant exposure to other chemicals,

[2] EPA Health Effects Notebook for Hazardous Air Pollutants: http://www.epa.gov/ttn/atw/hlthef/hapindex.html

inadequate sample size, and lack of quantitative exposure data. EPA has classified benzene as a known human carcinogen by inhalation.

1,3-Butadiene is a colorless gas with a mild gasoline-like odor. Sources of 1,3-butadiene released into the air include motor vehicle exhaust, manufacturing and processing facilities, forest fires or other combustion, and cigarette smoke. Acute exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat, and lungs. Neurological effects, such as blurred vision, fatigue, headache, and vertigo, have also been reported at very high exposure levels. One epidemiological study reported that chronic exposure to 1,3-butadiene via inhalation resulted in an increase in cardiovascular diseases, such as rheumatic and arteriosclerotic heart diseases, while other human studies have reported effects on the blood. No information is available on reproductive or developmental effects of 1,3-butadiene in humans. EPA has classified 1,3-butadiene as a probable human carcinogen by inhalation.

Diesel Particulate Matter/Diesel Exhaust Organic Gases are a complex mixture of hundreds of constituents in either a gaseous or particle form. Gaseous components of diesel exhaust (DE) include CO2, oxygen, nitrogen, water vapor, CO, nitrogen compounds, sulfur compounds, and numerous low-molecular-weight hydrocarbons. Among the gaseous hydrocarbon components of DE that are individually known to be of toxicological relevance are several carbonyls (e.g., formaldehyde, acetaldehyde, acrolein), benzene, 1,3-butadiene, and polycyclic aromatic hydrocarbons (PAHs) and nitro-PAHs. DPM is composed of a center core of elemental carbon and adsorbed organic compounds, as well as small amounts of sulfate, nitrate, metals, and other trace elements. DPM consists primarily of PM2.5, including a subgroup with a large number of particles having a diameter <0.1 µm. Collectively, these particles have a large surface area, which makes them an excellent medium for adsorbing organics. Also, their small size makes them highly respirable and able to reach the deep lung. A number of potentially toxicologically-relevant organic compounds, including PAHs, nitro-PAHs, and oxidized PAH derivatives, are on the particles. Diesel exhaust is emitted from on-road mobile sources, such as automobiles and trucks, and from off-road mobile sources (e.g., diesel locomotives, marine vessels, and construction equipment). DPM is directly emitted from diesel-powered engines (primary particulate matter) and can be formed from the gaseous compounds emitted by diesel engines (secondary particulate matter).

Acute or short-term (e.g., episodic) exposure to DE can cause acute irritation (e.g., eye, throat, bronchial), neurophysiological symptoms (e.g., lightheadedness, nausea), and respiratory symptoms (cough, phlegm). Evidence also exists for an exacerbation of allergenic responses to known allergens and asthma-like symptoms. Information from the available human studies is inadequate for a definitive evaluation of possible non-cancer health effects from chronic exposure to DE. However, on the basis of extensive animal evidence, DE is judged to pose a chronic respiratory hazard to humans. EPA has determined that DE is “likely to be carcinogenic to humans by inhalation” and that this hazard applies to environmental exposures.

Formaldehyde is a colorless gas with a pungent, suffocating odor at room temperature. The major emission sources of formaldehyde appear to be power plants, manufacturing facilities, incinerators, and automobile exhaust. However, most of the formaldehyde in ambient air is a result of secondary formation through photochemical reaction of VOC and NOX. The major toxic effects caused by acute formaldehyde exposure via inhalation are eye, nose, and throat irritation and effects on the nasal cavity. Other effects seen from exposure to high levels of formaldehyde in humans are coughing, wheezing, chest pains, and bronchitis. Chronic exposure to formaldehyde by inhalation in humans has been associated with respiratory symptoms and eye, nose, and throat irritation. EPA considers formaldehyde to be a probable human carcinogen.

Naphthalene is used in the production of phthalic anhydride; it is also used in mothballs. Acute (short-term) exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and neurological damage. Cataracts have also been reported in workers acutely exposed to naphthalene by inhalation and ingestion. Chronic (long-term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and damage to the retina. Hemolytic anemia has been reported in infants born to mothers who "sniffed" and ingested naphthalene (as mothballs) during pregnancy. Available data are inadequate to establish a causal relationship between exposure to naphthalene and cancer in humans. EPA has classified naphthalene as a Group C, possible human carcinogen.

The term **Polycyclic Organic Matter (POM)** defines a broad class of compounds that includes the polycyclic aromatic hydrocarbon compounds (PAH), of which benzo[a]pyrene is a member. POM compounds are formed primarily from combustion and are present in the atmosphere in particulate form. Sources of air emissions are diverse and include cigarette smoke, vehicle exhaust, home heating, laying tar, and grilling meat. Cancer is the major concern from exposure to POM. Epidemiologic studies have reported an increase in lung cancer in humans exposed to coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain POM compounds. Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene and forestomach tumors, leukemia, and lung tumors from oral exposure to benzo[a]pyrene. EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.

3.5 CLIMATE CHANGE AND GREENHOUSE GASES

Climate change is an important national and global concern. While the earth has gone through many natural changes in climate in its history, there is general agreement that the earth's climate is currently changing at an accelerated rate and will continue to do so for the foreseeable future. Anthropogenic (human-caused) greenhouse gas (GHG) emissions contribute to this rapid change. Carbon dioxide (CO_2) makes up the largest component of these GHG emissions. Other prominent transportation GHGs include methane (CH_4) and nitrous oxide (N_2O).

Many GHGs occur naturally. Water vapor is the most abundant GHG and makes up approximately two thirds of the natural greenhouse effect. However, the burning of fossil fuels and other human activities are adding to the concentration of GHGs in the atmosphere. Many GHGs remain in the atmosphere for time periods ranging from decades to centuries. GHGs trap heat in the earth's atmosphere. Because atmospheric concentration of GHGs continues to climb, our planet will continue to experience climate-related phenomena. For example, warmer global temperatures can cause changes in precipitation and sea levels. To date, no national standards have been established regarding GHGs, nor has EPA established criteria or thresholds for ambient GHG emissions pursuant to its authority to establish motor vehicle emission standards for CO_2 under the Clean Air Act. However, there is a considerable body of scientific literature addressing the sources of GHG emissions and their adverse effects on climate, including reports from the Intergovernmental Panel on Climate Change, the US National Academy of Sciences, and EPA and other Federal agencies. GHGs are different from other air pollutants evaluated in Federal environmental reviews because their impacts are not localized or regional due to their rapid dispersion into the global atmosphere, which is characteristic of these gases. The *affected environment* for CO_2 and other GHG emissions is the entire planet. In addition, from a quantitative perspective, global climate change is the cumulative result of numerous and varied emissions sources (in terms of both absolute numbers and types), each of which makes a relatively small addition to global atmospheric GHG concentrations. In contrast to broad scale actions such as actions involving an entire industry sector or very large geographic areas, it is difficult to isolate and understand the GHG emissions impacts for a particular transportation project. Furthermore, presently there is no scientific methodology for attributing specific climatological changes to a particular transportation project's emissions.[3]

EPA and the National Highway Traffic Safety Administration (NHTSA) are taking coordinated steps to enable the production of a new generation of clean vehicles, through reduced greenhouse gas (GHG) emissions and improved fuel use from on-road vehicles and engines, from the smallest cars to the largest trucks. The agencies finalized standards to extend the light-duty vehicle GHG National Program for model years 2017-2025. In addition, the agencies have adopted first-ever GHG regulations for heavy-duty engines and vehicles. On September 30, 2009, EPA announced a proposal that is focused on large facilities emitting over 25,000 tons of greenhouse gases a year. These facilities would be required to obtain permits that would demonstrate they are using the best practices and technologies to minimize GHG emissions.

[3] Federal Highway Administration, Resource Center, July 2013.

4 ENVIRONMENTAL CONSEQUENCES

4.1 SOURCES OF EMISSIONS

The pollutants that are most important to this air quality impact analysis are those that can be traced principally to motor vehicles. In the project area, emissions of SO_x and Pb are associated mainly with various stationary sources. Emissions of VOC, NO_x and PM_{10} come from both mobile and stationary sources. Emissions of CO, $PM_{2.5}$ and DPM are predominantly influenced by motor vehicle activity.

The VOC and NO_x emissions from automotive sources are a concern primarily because they are precursors in the formation of ozone and particulate matter. Ozone is formed through a series of reactions which occur in the atmosphere in the presence of sunlight. Since the reactions are slow and occur as the pollutants are diffusing downwind, elevated ozone levels often are found many miles from sources of the precursor pollutants. Therefore, the effects of VOC and NO_x emissions are generally examined on a regional or "mesoscale" basis.

The PM_{10} and $PM_{2.5}$ impacts are both regional and local. A significant portion of particulate matter, especially PM_{10}, comes from disturbed vacant land, construction activity, and paved road dust. The $PM_{2.5}$ also comes from these sources. Motor vehicle exhaust, particularly from diesel vehicles, is also a source of PM_{10} and $PM_{2.5}$. Thus, it is appropriate to analyze PM_{10} and $PM_{2.5}$ on both a regional and a localized basis.

The MSAT impacts are both regional and local. Through the issuance of USEPA's Final Rule (FR) regarding emission control of Hazardous Air Pollutants from Mobile Sources [66 FR 17229], it was determined that many existing and newly promulgated mobile source emission control programs would result in a reduction of MSATs. The USEPA examined the impacts of existing and newly promulgated mobile source control programs, including its reformulated gasoline program, its national low emission vehicle standards, its Tier 2 motor vehicle emissions standards and gasoline sulfur control requirements, and its proposed heavy duty engine and vehicle standards and on-highway diesel fuel requirements. Future emissions likely would be lower than present levels as a result of the USEPA's national control programs that are projected to reduce MSAT emission on a national level[4] by 83 percent from 2010 to 2050, even if VMT increases by 102 percent. Though MSAT emissions are predicted to be lower in the future, EPA has requested that a microscale MSAT analysis along with a Health Risk Assessment be conducted for this project.

The CO impacts are generally localized. Even under the worst meteorological conditions and most congested traffic conditions, high concentrations of CO are limited within a relatively short distance (300–600 feet) of heavily traveled roadways. Vehicle emissions are the major sources of CO. The proposed eight project scenarios could change traffic patterns within the study area. Consequently, it is appropriate to predict concentrations of CO on both a regional and a localized or "microscale" basis.

4.2 ANALYSIS METHODOLOGY

The SEIS air quality analysis evaluated the preferred scenario and the worst case scenario out of the eight future proposed scenarios (presented in Section 2). The Finegayan NWF is the preferred scenario. To determine which scenario would represent the worst case scenario for air quality, the daily VMT of the scenarios were compared to each other. As shown in Table 4-1, the 2030 Barrigada NWF scenario is

[4] Although Guam is still federally exempt from having to use ultra low sulfur diesel (ULSD) fuel, locally Guam passed a law (January 2011), requiring all diesel fuel sold or distributed on Guam to be ULSD.

predicted to have the highest daily VMT of all the proposed scenarios. As such, the Barrigada NWF was chosen to represent the scenario with the highest potential air quality impacts. The impacts of the remaining scenarios were qualitatively compared to the results of the quantitative analyses.

Based on traffic planning analyses conducted using results from the travel demand forecasting, (Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS)), it was determined that 2021 represents the peak construction year for the project. It was also determined that the Finegayan scenario represents both the preferred scenario and the worst case scenario. This is because 66% of the total construction related truck traffic is from the quarries to the Main Cantonment and Family Housing. Finegayan is the site furthest from the quarries. Another 18% of trucks are from Apra Port to the Main Cantonment and Family Housing, and Finegayan is far from the port (AAFB is slightly further, Barrigada is closest to the port). As such, the analysis of the Finegayan scenario in 2021 represents both the preferred and worst case scenarios.

In addition, the Baseline (No Build) Scenario has been analyzed to compare air quality results with and without the project.

Table 4-1. Daily VMT by Scenario

Scenario	Daily VMT	Additional Attributable to Project	Daily VHT	Additional Attributable to Project
2012 Baseline	2,323,962		89,704	
2030 Baseline	2,697,073		105,960	
2030 No Action	3,196,385	499,312	137,358	31,398
2030 Finegayan NWF	2,783,084	86,011	109,624	3,664
2030 AAFB	2,784,255	87,182	109,623	3,663
2030 Finegayan	2,784,559	87,486	109,740	3,780
2030 South Finegayan	2,790,464	93,391	109,969	4,009
2030 BarrigadaRte15	2,799,756	102,683	110,139	4,179
2030 Barrigada NWF	2,800,817	103,744	110,158	4,198

Source: Parsons Brinckerhoff Planning, September 2013

4.2.1 Local (Hot-spot) Particulate Matter Analysis

On March 10, 2006, EPA published a final rule establishing transportation conformity requirements for analyzing the local PM air quality impacts of transportation projects (71 FR 12468). The conformity rule required a qualitative PM hot-spot analysis to be performed until EPA released guidance on how to conduct quantitative PM hot-spot analyses and announced in the Federal Register that such requirements are in effect (40 CFR 93.123(b)). In December of 2010, EPA released *Transportation Conformity Guidance for Quantitative Hot-spot Analysis in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (USEPA, 2010) (http://www.epa.gov/otaq/stateresources/transconf/policy/420b10040.pdf), which became effective in December of 2012. This rule requires that $PM_{2.5}$ and/or PM_{10} hotspot analysis be performed for transportation projects with significant diesel traffic in areas not meeting $PM_{2.5}$ and/or PM_{10} air quality standards.

For the Guam and CNMI Military Relocation (2012 Roadmap Adjustments), the project study area is classified as an attainment area for PM_{10} and $PM_{2.5}$. As such, PM_{10} and $PM_{2.5}$ hotspot analyses are not required to comply with transportation conformity. However due to concern regarding potential increases in local diesel truck traffic, the project's impact on local PM_{10} and $PM_{2.5}$ levels have been assessed for purposes of disclosure of potential impacts under NEPA.

Projects which require a quantitative $PM_{2.5}$ or PM_{10} hot-spot analysis, as defined in Section 93.123(b)(1) of the conformity rule, include:

- New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles;
- Projects affecting intersections that are at Level-of-Service D, E, or F with a significant number of diesel vehicles, or those that will change to Level-of Service D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project;
- New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location;
- Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location; and
- Projects in or affecting locations, areas, or categories of sites which are identified in the $PM_{2.5}$ or PM_{10} applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation.

Some examples of projects of local air quality concern that would be covered by 40 CFR 93.123(b)(1)(i) and (ii) are:

- A project on a new highway or expressway that serves a significant volume of diesel truck traffic, such as facilities with greater than 125,000 annual average daily traffic (AADT) and 8% or more of such AADT is diesel truck traffic;
- New exit ramps and other highway facility improvements to connect a highway or expressway to a major freight, bus, or intermodal terminal;
- Expansion of an existing highway or other facility that affects a congested intersection (operated at Level-of-Service D, E, or F) that has a significant increase in the number of diesel trucks; and,
- Similar highway projects that involve a significant increase in the number of diesel transit busses and/or diesel trucks.

4.2.2 Local (Hot-spot) Carbon Monoxide Analysis

Microscale air quality modeling was performed using the most recent version of the USEPA mobile source emission factor model (MOVES2010b, EPA 2012) and the CAL3QHC (Version 2.0) air quality dispersion model (USEPA 1995b) to estimate existing, future no-build (without the proposed project) and future build (with the proposed project) CO levels at selected locations in the project area.

Mobile source models are the basic analytical tools used to estimate CO concentrations expected under given traffic, roadway geometry, and meteorological conditions. The mathematical expressions and formulations that comprise the various models attempt to describe an extremely complex physical phenomenon as closely as possible. The dispersion modeling program used in this project for estimating pollutant concentrations near roadway intersections is the CAL3QHC (Version 2.0) dispersion model developed by USEPA and first released in 1992.

CAL3QHC is a Gaussian model recommended in the USEPA's Guidelines for Modeling Carbon Monoxide from Roadway Intersections (USEPA 1992). Gaussian models assume that the dispersion of pollutants downwind of a pollution source follow a normal distribution from the center of the pollution source.

Different emission rates occur when vehicles are stopped (i.e., idling), accelerating, decelerating, and moving at different average speeds. CAL3QHC simplifies these different emission rates into two components:

- Emissions when vehicles are stopped (i.e., idling) during the red phase of a signalized intersection
- Emissions when vehicles are in motion during the green phase of a signalized intersection

The CAL3QHC (Version 2.0) air quality dispersion model has undergone extensive testing by USEPA and has been found to provide reliable estimates of inert (i.e., nonreactive) pollutant concentrations resulting from motor vehicle emissions. A complete description of the model is provided in the User's Guide to CAL3QHC (Version 2.0): A Modeling Methodology for Predicting Pollutant Concentrations near Roadway Intersections (Revised) (USEPA 1995b).

Emission factors were developed using the latest version of EPA's Motor Vehicle Emission Simulator (MOVES), MOVES2010b. MOVES2010b is the U.S. Environmental Protection Agency's (EPA's) state-of-the-art tool for estimating emissions from highway vehicles. The model is based on analyses of millions of emission test results and considerable advances in the Agency's understanding of vehicle emissions. Compared to previous tools, MOVES2010b incorporates the latest emissions data, more sophisticated calculation algorithms, increased user flexibility, new software design, and significant new capabilities. The MOVES model incorporates a database of area specific county level parameters that may be used in emissions analysis. Guam however is not included in this database. EPA recommended that the incorporated database for the US Virgin Islands be used to represent Guam. This approach is consistent with the approach taken in the air quality analyses done for other components of the overall project and was applied to this element of the project. For the CO analysis, emission factors were calculated for the winter AM and PM peak periods. Unique emission factors were developed by taking the appropriate peak hour traffic data (volumes, speeds and vehicle classification) for each roadway segment (link) within the analysis site. Link by link traffic data was obtained from the Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report, Parsons Brinckerhoff, September 2013. The MOVES run files and outputs are contained in Appendix A (electronic).

A screening evaluation was performed on the 65 intersections identified in the project area as the most congested and most affected by the 2030 worst case scenario (Barrigada NWF) and the locally preferred scenario (Finegayan NWF) , as shown in Table 4-2, Table 4-3, and Table 4-4. Sites fail the screening evaluation if (1) the LOS decreases below D in one of the build scenarios compared to the no-build scenario, or (2) if the delay and/or volume increase from the no-build scenario to build scenarios along with a LOS below D. The LOS describes the quality of traffic operating conditions, ranging from A to F, and it is measured as the duration of delay that a driver experiences at a given intersection. LOS A represents free-flow movement of traffic and minimal delays to motorists. LOS F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in congestion. Out of the 65 intersection, 6 intersections were chosen for detailed analysis due to poor level of service, high volumes, proximity to sensitive receptors and geographical representation. The intersections chosen for detailed analyses are:

- Route 3/9/Chalan Santa Anita
- Route 1 / Route 3
- Route 16 / Route 27
- Route 1 / Route 14A
- Route 10 / Route 15
- Route 1 / Route 2A

The transport and concentration of pollutants emitted from motor vehicles are influenced by three principal meteorological factors: wind direction, wind speed, and the atmosphere's profile. The values for these parameters were chosen to maximize pollutant concentrations at each prediction site. That is, to establish a conservative, reasonable worst-case scenario. The values used for these parameters are:

- **Wind Direction**. Maximum CO concentrations normally are found when the wind is assumed to blow parallel to a roadway adjacent to the receptor location. At complex intersections, it is difficult to predict which wind angle will result in maximum concentrations. Therefore, the approximate wind angle that would result in maximum pollutant concentrations at each receptor location was used in the analysis. All wind angles from 0 to 360 degrees (in 5-degree increments) were considered.

- **Wind Speed**. The CO concentrations are greatest at low wind speeds. A conservative wind speed of one meter per second (2.2 miles per hour) was used to predict CO concentrations during peak traffic periods.

- **Profile of the Atmosphere**. A "mixing" height (the height in the atmosphere to which pollutants rise) of 1,000 meters, and neutral atmospheric stability (stability class D) conditions were used in estimating microscale CO concentrations.

A background value must be added into the results of the dispersion analysis to account for others sources of CO that are not accounted for in the CAL3QHC modeling. Usually a value from a representative local ambient air quality monitor is used. Guam, however, does not have any local monitoring stations, as discussed earlier in this chapter. Due to this, and as was done in previous approved documents for this project, values from Hawaii were examined to determine their applicability to Guam. Using the 2010–2012 monitored data from the Punchbowl monitor, (rated as a middle scale monitor) located in Honolulu, Hawaii, the second highest maximum 1-hour reading was 1.5 parts ppm. This value was conservatively rounded to 2.0 ppm and represents the background CO concentration for this analysis.

The one-hour CO levels are the maximum concentrations expected to occur at each air quality receptor site analyzed. The results are based on the simultaneous occurrence of a number of worst-case conditions, such as peak hour traffic conditions, worst case vehicular queuing, conservative vehicular operating conditions, low wind speed, low atmospheric temperature, neutral atmospheric conditions, and maximizing wind direction.

Peak eight-hour concentrations of CO were obtained by multiplying the highest peak hour CO estimates by a persistence factor. The persistence factor accounts for the fact that:

- Over eight hours (as distinct from a single hour) vehicle volumes will fluctuate downward from the peak hour.
- Vehicle speeds may vary.
- Meteorological conditions, including wind speed and wind direction, will vary compared to the conservative assumptions used for the single hour.

The USEPA-recommended persistence factor of 0.7 was used in this analysis.

Table 4-2. Guam Intersection Screening – North

Intersection			AM									PM								
			2030 No Build			2030 Finegayan/NWF			2030 Barrigada/NWF			2030 No Build			2030 Finegayan/NWF			2030 Barrigada/NWF		
#	Location	Control	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume
1	Route 3 / Route 3A	TWSC	16.1	C	840	32.6	D	1,290	18.2	C	870	11.5	B	760	18.6	C	1,250	12.5	B	800
2	Route 3/9 / Chalan Santa Anita	TWSC	37.7	E	870	> 180.0	F	1,300	43.5	E	900	15.0	B	690	34.5	D	1,170	15.7	C	730
3	Route 9 / Route 3A	TWSC	14.7	B	700	21.4	C	1,100	14.4	B	740	13.6	B	580	24.7	C	1,030	15.3	C	640
4	Route 3 / Bullard Avenue	TWSC	19.0	C	1,400	21.2	C	1,720	19.3	C	1,430	12.4	B	980	15.7	C	1,395	12.7	B	1,020
5	Route 3 / Route 28	Signalized	33.7	C	2,710	40.4	D	3,060	35.8	D	2,750	23.2	C	2,040	26.4	C	2,490	23.3	C	2,100
6	Route 3 / Royal Palm Drive	TWSC	36.4	E	2,570	57.8	F	2,840	47.5	E	2,610	14.8	B	1,995	16.1	C	2,350	14.4	B	2,050
7	Route 1/9 / AAFB Entrance	Signalized	17.1	B	1,330	17.9	B	1,490	17.6	B	1,460	31.2	C	1,410	33.5	C	1,620	32.1	C	1,570
8	Route 1 / Route 29	Signalized	34.2	C	2,780	35.0	C	2,860	34.6	C	2,920	23.3	C	2,795	24.6	C	2,930	23.8	C	2,970
9	Route 15 / Route 29	TWSC	102.0	F	1,195	113.0	F	1,210	109.3	F	1,200	31.2	D	920	31.6	D	930	33.7	D	930
10	Route 1 / Chalan Lajuna	Signalized	19.9	B	3,200	20.5	C	3,250	22.5	C	3,370	13.8	B	2,900	14.1	B	3,010	16.4	B	3,090
11	Route 15 / Chalan Lajuna	TWSC	75.8	F	980	86.0	F	1,000	> 180.0	F	1,090	82.6	F	1,080	92.7	F	1,110	> 180.0	F	1,220
12	Route 1 / Route 3	Signalized	> 180.0	F	4,990	> 180.0	F	5,280	> 180.0	F	5,030	63.4	E	4,170	90.1	F	4,510	65.2	E	4,220
13	Route 1 / Route 16	Signalized	21.9	C	4,780	25.9	C	4,980	22.9	C	4,830	45.3	D	5,100	62.3	E	5,400	49.3	D	5,190
14	Route 1 / Route 14 (Pale San Vitores)	Signalized	32.4	C	4,100	37.6	D	4,210	33.6	C	4,110	43.2	D	5,210	47.0	D	5,390	43.9	D	5,240
15	Route 16 / Route 27A	Signalized	24.0	C	2,800	24.1	C	2,900	24.3	C	2,860	18.8	B	3,380	18.9	B	3,500	19.0	B	3,470
16	Route 1 / Route 27A	Signalized	37.3	D	2,945	37.9	D	3,030	38.0	D	2,980	46.4	D	2,960	46.7	D	3,020	46.7	D	3,010
17	Route 28 / Route 27A	AWSC	11.7	B	980	12.1	B	1,000	11.9	B	990	65.0	F	1,570	65.0	F	1,570	68.1	F	1,580
18	Route 1 / Route 27	Signalized	118.3	F	4,240	118.5	F	4,300	134.1	F	4,360	50.2	D	4,250	54.6	D	4,310	60.7	E	4,400
19	Route 1 / Route 26	Signalized	34.4	C	4,585	36.4	D	4,620	40.5	D	4,680	87.6	F	4,860	89.4	F	4,920	94.9	F	5,040
20	Route 1 / Route 28	Signalized	53.5	D	3,910	54.1	D	3,940	57.3	E	3,990	37.1	D	4,370	37.6	D	4,390	38.8	D	4,440
21	Route 16 / Route 27	Signalized	> 180.0	F	5,510	> 180.0	F	5,620	> 180.0	F	5,720	154.7	F	5,970	159.0	F	6,120	165.9	F	6,220
61	Route 3 / USMC Main Gate	Signalized	-	-	-	39.8	D	1,765	-	-	-	-	-	-	25.5	C	1,785	-	-	-
62	Route 3 / USMC Secondary Gate	Signalized	-	-	-	15.5	B	1,890	-	-	-	-	-	-	7.3	A	1,480	-	-	-
63	Route 9 / AAFB North Gate	TWSC	-	-	-	19.6	C	965	12.3	B	650	-	-	-	13.5	B	925	10.7	B	585
64	Route 16 / USMC Secondary Gate	Signalized	-	-	-	-	-	-	4.6	A	2,830	-	-	-	-	-	-	2.7	A	2,820
65	Route 15 / USMC Main Gate	Signalized	-	-	-	-	-	-	22.3	C	1,785	-	-	-	-	-	-	10.7	B	2,145

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report and associated analyses.

Table 4-3. Guam Intersection Screening - Central

Intersection			AM									PM								
			2030 No Build			2030 Finegayan/NWF			2030 Barrigada/NWF			2030 No Build			2030 Finegayan/NWF			2030 Barrigada/NWF		
#	Location	Control	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume
22	Route 16 / Route 10A	Signalized	> 180.0	F	3,645	> 180.0	F	3,700	> 180.0	F	3,670	49.1	D	3,715	53.9	D	3,780	50.3	D	3,760
23	Route 26 / Route 25	Signalized	26.2	C	2,110	26.3	C	2,140	27.1	C	2,180	9.6	A	2,260	9.7	A	2,280	9.9	A	2,330
24	Route 15 / Route 26	TWSC	145.2	F	1,705	166.6	F	1,740	> 180.0	F	1,920	> 180.0	F	1,680	> 180.0	F	1,720	> 180.0	F	1,940
25	Route 10A / Sunset Blvd (Airport)	Signalized	27.6	C	3,275	30.0	C	3,350	29.9	C	3,310	54.4	D	3,400	57.9	E	3,480	54.2	D	3,450
26	Route 1 / Route 14A	Signalized	35.2	D	4,420	37.3	D	4,520	35.5	D	4,450	> 180.0	F	6,910	> 180.0	F	7,020	> 180.0	F	6,930
27	Route 1 / Route 10A	Signalized	53.0	D	5,110	54.5	D	5,180	54.9	D	5,170	139.3	F	5,990	144.7	F	6,090	143.2	F	6,050
28	Route 1 / Route 14B	Signalized	38.3	D	4,325	42.8	D	4,400	41.3	D	4,370	30.4	C	4,975	32.3	C	5,080	31.8	C	5,010
29	Route 1 / Route 14	Signalized	73.4	E	4,760	77.3	E	4,820	79.8	E	4,860	50.8	D	5,640	53.2	D	5,770	52.5	D	5,710
30	Route 1 / Route 30	Signalized	55.1	E	4,340	58.7	E	4,390	63.5	E	4,430	42.5	D	4,840	43.9	D	4,930	45.7	D	4,930
31	Route 1 / Route 6 (Adelup)	Signalized	18.3	B	3,330	18.7	B	3,380	18.5	B	3,450	25.6	C	3,030	25.8	C	3,070	26.0	C	3,140
32	Route 1 / Route 4	Signalized	10.1	B	4,590	10.3	B	4,640	10.7	B	4,750	16.7	B	4,600	17.4	B	4,790	17.4	B	4,820
33	Route 1 / Route 8	Signalized	14.9	B	4,840	14.6	B	4,890	16.0	B	5,050	19.6	B	4,900	19.2	B	5,040	20.3	C	5,140
34	Route 8 / Chalan Santo Papa	TWSC	86.5	F	2,330	87.6	F	2,350	127.7	F	2,470	158.9	F	2,560	161.2	F	2,570	> 180.0	F	2,710
35	Route 8 / Route 7A	Signalized	19.6	B	3,560	20.3	C	3,630	22.1	C	3,800	58.2	E	4,080	59.5	E	4,100	74.6	E	4,320
36	Route 4 / Chalan Santo Papa	Signalized	31.3	C	2,520	31.1	C	2,520	32.1	C	2,560	37.6	D	2,750	37.7	D	2,830	37.5	D	2,820
37	Route 4 / Route 7A	Signalized	50.1	D	3,530	52.1	D	3,580	55.8	E	3,650	53.4	D	3,700	54.8	D	3,750	57.3	E	3,830
38	Route 4 / Route 7B	TWSC	32.3	D	2,710	39.9	E	2,730	39.9	E	2,730	161.3	F	2,830	159.5	F	2,840	171.6	F	2,880
39	Route 7A / Route 7	Signalized	29.4	C	2,170	29.9	C	2,190	30.1	C	2,200	26.6	C	1,845	26.7	C	1,870	27.1	C	1,880
40	Route 8 / Sunset Blvd	TWSC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	Route 8 / Route 33	Signalized	40.7	D	2,550	40.7	D	2,550	53.1	D	2,830	17.8	B	1,630	18.3	B	1,640	19.9	B	1,920
42	Route 8 / Route 10	Signalized	24.8	C	3,960	24.9	C	4,010	28.6	C	4,370	24.7	C	3,690	25.2	C	3,730	28.4	C	4,130
43	Route 16 / Route 8A	Signalized	17.2	B	2,870	17.4	B	2,900	17.4	B	3,060	6.7	A	2,770	6.7	A	2,810	7.1	A	2,980
44	Route 10 / Route 15	Signalized	43.7	D	3,870	43.8	D	3,890	72.2	E	4,440	33.4	C	3,550	34.6	C	3,590	64.2	E	4,170
45	Route 4 / Route 15	Signalized	73.4	E	2,920	76.9	E	2,930	79.3	E	2,950	36.4	D	2,715	37.3	D	2,720	39.2	D	2,790
46	Route 4 / Route 10	Signalized	73.8	E	3,525	74.2	E	3,540	76.8	E	3,590	53.0	D	3,040	54.4	D	3,070	56.4	E	3,110
47	Route 1 / Route 11	Signalized	10.8	B	2,730	10.9	B	2,780	10.9	B	2,840	14.2	B	2,520	14.0	B	2,560	13.8	B	2,630
48	Route 1 / Route 6 (Veterans Cemetery)	Signalized	10.0	A	2,560	9.9	A	2,610	9.7	A	2,670	12.8	B	2,320	12.6	B	2,350	12.2	B	2,420
49	Route 1 / Polaris Point	Signalized	11.2	B	2,680	11.2	B	2,720	11.2	B	2,780	5.7	A	2,210	5.7	A	2,260	5.8	A	2,320
58	Tiyan Parkway / Route 10A	Signalized	34.5	C	3,880	34.7	C	3,960	35.3	D	3,930	60.5	E	4,270	61.5	E	4,330	62.9	E	4,310
59	Tiyan Parkway / Route 8	Signalized	58.2	E	4,130	60.1	E	4,180	72.0	E	4,400	47.0	D	4,440	49.0	D	4,480	56.0	E	4,750
60	Route 1 / Route 27 Extension	Signalized	19.9	B	4,155	20.1	C	4,270	20.5	C	4,210	9.0	A	5,680	12.2	B	5,820	9.9	A	5,720

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report and associated analyses.

Table 4-4. Guam Intersection Screening - South

Intersection			AM									PM								
			2030 No Build			2030 Finegayan/NWF			2030 Barrigada/NWF			2030 No Build			2030 Finegayan/NWF			2030 Barrigada/NWF		
#	Location	Control	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume	Delay	LOS	Volume
50	Route 1 / Route 2A	Signalized	13.6	B	2,780	13.4	B	2,810	13.4	B	2,880	22.9	C	2,530	23.2	C	2,580	23.5	C	2,640
51	Route 2A / Route 5	Signalized	20.9	C	1,680	20.9	C	1,680	20.9	C	1,680	18.4	B	1,340	18.4	B	1,340	18.4	B	1,340
52	Route 2 / Route 12	Signalized	26.1	C	1,760	26.1	C	1,770	26.1	C	1,770	14.6	B	1,490	14.6	B	1,490	14.6	B	1,490
53	Route 17 / Route 5	TWSC	26.3	D	920	27.5	D	930	26.3	D	920	16.0	C	680	16.2	C	690	16.2	C	690
54	Route 12 / Naval Magazine Entrance	TWSC	9.7	A	240	9.7	A	240	9.7	A	240	8.9	A	130	9.0	A	140	9.0	A	140
55	Route 17 / Route 4A	TWSC	21.8	C	770	23.5	C	790	22.9	C	780	24.1	C	690	24.1	C	690	24.1	C	690
56	Route 4 / Route 17	Signalized	62.6	E	1,660	67.2	E	1,700	70.0	E	1,700	21.5	C	1,110	22.1	C	1,120	22.5	C	1,130
57	Route 4 / Route 4A	TWSC	22.8	C	730	22.8	C	730	24.8	C	750	12.3	B	560	12.3	B	560	12.3	B	560

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report and associated analyses.

4.2.3 Mobile Source Air Toxics

As part of the National Environmental Policy Act (NEPA) process, Environmental Impact Statements (EISs) require review and evaluation of air toxics as they could affect the quality of the human environment. For this analysis, a tiered approach developed by the FHWA in the *Interim Guidance Update on Mobile Source Air Toxic Analysis in NEPA* (December 6, 2012) was used, which includes the following three levels of analysis:

- No analysis for projects with no potential for meaningful MSAT effects;
- Qualitative analysis for projects with low potential MSAT effects; or
- Quantitative analysis to differentiate scenarios for projects with higher potential MSAT effects.

Based on community concerns, a *quantitative analysis to differentiate scenarios for projects with higher potential MSAT effects* was conducted. This approach was also taken in the 2010 Final EIS for the project. As such, a screening-level MSAT dispersion modeling analysis was conducted to estimate whether the incremental health-related risk associated with the proposed project would exceed the following thresholds:

- A maximum total incremental carcinogenic risk from the exposure to all identified pollutants of 10 in a million (i.e., 10×10^{-6}); and
- A maximum total incremental non-carcinogenic Hazard Index risk from the exposure to all identified pollutants of 1.

The procedures and thresholds used to estimate cancer risk and hazard index of toxic pollutants are based on inhalation exposure concentrations that are outlined in the EPA Human Health Risk Assessment Protocol (HHRAP). The HHRAP is a guideline that can be used to perform health risk assessment for individual compounds with known health effects to determine the level of health risk posed by an increased ambient concentration of that compound at a potentially sensitive receptor. The derived health risk values from the HHRAP were used in this analysis to determine the total risk posed by the release of multiple MSATs.

The following MSATs, which are carcinogenic and non-carcinogenic pollutants, were analyzed:

- Acrolein
- Benzene
- 1,3-butadiene
- Diesel particulate matter plus diesel exhaust organic gases (diesel PM)
- Formaldehyde
- Naphthalene
- POM (Polycyclic Organic Matter)

POM was estimated as being comprised of the following chemicals, which were analyzed on a pollutant-by pollutant basis:

- acenaphthene
- acenapthylene
- anthracene
- benz[A]anthracene
- benzo[b]fluoranthene
- benzo[g,h,i]perylene
- benzo[K]fluoranthene

- benzo[A]pyrene
- chrysene
- dibenzo[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-cd]pyrene,
- phenanthrene, and
- pyrene.

Emission factors were developed using EPA's Motor Vehicle Emission Simulator (MOVES). MOVES is the U.S. Environmental Protection Agency's (EPA's) state-of-the-art tool for estimating emissions from highway vehicles. The model is based on analyses of millions of emission test results and considerable advances in the Agency's understanding of vehicle emissions. Compared to previous tools, MOVES incorporates the latest emissions data, more sophisticated calculation algorithms, increased user flexibility, new software design, and significant new capabilities.

The CAL3QHCR dispersion model was used with the same worst case meteorology used in the CO microscale analysis, to estimate 1-hour concentrations of each MSAT at sensitive receptor locations. These concentrations were used to estimate acute (short-term) impacts. The 1-hour values were then converted, using conservative traffic and meteorological persistence factors, to annual values in order to estimate annual impacts. The years 2021 and 2030, which represent the peak construction year and the design year, respectively, were analyzed.

Carcinogenic MSATs were evaluated using unit risk factors; non-carcinogenic MSATs were evaluated using the reference concentrations for chronic inhalation exposure (RfC) and/or acute inhalation exposure (AIEC). RfC and AIEC were used to estimate the non-carcinogenic health effects of substances that are also carcinogens. The threshold values (benchmarks) used for this analysis, which are based on guideline values provided in USEPA's Human Health Risk Assessment Protocol, are shown in Table 4-5.

The appropriate unit risk factors for the carcinogenic pollutants were applied to the estimated exposure concentrations to determine the maximum overall incremental cancer risk at each analysis site. As per EPA's recommendation, a 30 year and a 70 year exposure duration is used in the analysis.

Table 4-5. Unit Health Risk Factors

MSAT	GAS No.	Toxicity	AIEC (ug/m^3) (1) (1-hour Values)	RfC (ug/m^3) (2) (Annual Values)	Unit Risk Factors (ug/m^3)
Acrolein	107-02-8	non-carcinogen	0.19	0.02	-
Acenaphthylene	208-96-8	non-carcinogen	NA	NA	NA
Benzene	71-43-2	carcinogen	1,300	30	7.8E-06(3)
1,3-Butadiene	106-99-0	carcinogen		2.3	3.0E-05
Diesel PM		non-carcinogen		5	
Formaldehyde	50-00-0	carcinogen	94	9.8	1.3E-05
Naphthalene	91-20-3	non-carcinogen	75,000	3.0	
Acenaphthene	83-32-9	non-carcinogen	1300	210	
Anthracene	120-12-7	non-carcinogen	600	1,000	
Benzo[b]fluoranthene	205-99-2	carcinogen	600		1.1E-04
Benzo[g,h,i]perylene	191-24-2	non-carcinogen	NA	NA	NA
Benzo[K]fluoranthene	207-08-9	carcinogen	600		1.1E-04
Benzo[A]anthracene	56-55-3	carcinogen	300		1.1E-04
Benzo[A]pyrene	50-32-8	carcinogen	600		1.1E-03
Chrysene	218-01-9	carcinogen	600		1.1E-05
Dibenzo[a,h]anthracene	53-70-3	carcinogen	30,000		1.2E-03
Fluoranthene	206-44-0	non-carcinogen	15	140	
Fluorene	86-73-7	non-carcinogen	11,560	140	
Indeno[1,2,3-cd]pyrene	193-39-5	carcinogen	500		1.1E-04
Phenanthrene	85-01-8	non-carcinogen	1,000		
Pyrene	129-00-0	non-carcinogen	15,000	110	

Notes:
1. AIEC = Acute Inhalation Exposure Concentration.
2. RfC= Reference Concentration (which is a daily exposure during a lifetime).
3. The unit risk factors for benzene range from 2.2E-06 to 7.8E-06. The most conservative value (7.8E-06 will be used in this analysis.
4. NA=Not Available, no recommended value is available for this exposure.

4.3 LOCAL PM_{10}/$PM_{2.5}$ ASSESSMENT

As shown in Table 4-6, the existing ADT of the roadways within the study area are well below the EPA example of 125,000 AADT and 8% diesel truck traffic, which equates to 10,000 trucks. As shown in Table 4-7 and Table 4-8, the future ADT, truck percentages and overall heavy vehicle volumes under the build scenarios are also well below the EPA example. The ADT and truck percentage information shown in these tables was developed from traffic planning analyses conducted specifically for this assessment, using results from the travel demand forecasting model (Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS).

Table 4-6. Existing Average Daily Traffic, Heavy Vehicle Percentages and Number of Heavy Vehicles on Roadways within Study Area

Route	Segment	2012 Existing ADT	% of Heavy Vehicles	Existing Number of Heavy Vehicles
Route 1	South of Route 6	23,102	2.42%	558
Route 11	West of Route 1	3,175	13.95%	443
Route 1	West of Route 7	31,243	3.61%	1,128
Route 4	North of Route 7A	18,500	2.11%	391
Route 1	East of Route 4	33,697	2.47%	831
Route 8	West of Chalan RS Sanchez	32,835	1.19%	392
Route 16	Between 8 and 10A	24,223	1.72%	417
Route 27	Between Route 16 and Route 1	20,470	1.32%	270
Route 1	North of Pale San Vitores Road	35,240	2.31%	814
Route 16	South of Route 1	17,263	2.36%	408
Route 3	North of Route 1	24,617	1.43%	351
Route 1	East of Route 28	40,807	2.68%	1,095
Chalan Lujuna	Between Route 1 and Route 15	5,596	3.34%	187
Route 1	South of AAFB	13,809	2.36%	326
Route 9	North of AAFB	5,252	2.17%	114
Route 15	South of Chalan Lujuna	7,456	2.64%	197
Route 1	North of Route 14A	35,721	2.85%	1,019

Source: Parsons Brinckerhoff Planning, September 2013.

Table 4-7. 2021 Average Daily Traffic, Heavy Vehicle Percentages and Number of Heavy Vehicles on Roadways within Study Area

Route	Segment	2021 No Build			2021 Build Finegayan NWF*		
		ADT	% of Heavy Vehicles	Number of Heavy Vehicles	ADT	% of Heavy Vehicles	Number of Heavy Vehicles
Route 1	South of Route 6	25,133	2.42%	607	26,268	2.70%	709
Route 11	West of Route 1	3,532	13.95%	493	4,159	20.82%	866
Route 1	West of Route 7	29,503	3.61%	1065	31,363	5.01%	1,571
Route 4	North of Route 7A	22,350	2.11%	472	22,289	2.09%	466
Route 1	East of Route 4	48,432	2.47%	1194	49,650	3.27%	1,624
Route 8	West of Chalan RS Sanchez	26,448	1.19%	316	27,253	1.33%	362
Route 16	Between 8 and 10A	33,858	1.72%	583	35,494	1.73%	614
Route 27	Between Route 16 and Route 1	26,342	1.32%	347	27,589	1.28%	353
Route 1	North of Pale San Vitores Road	51,939	2.31%	1200	54,303	2.96%	1,607
Route 16	South of Route 1	22,242	2.36%	526	23,207	2.37%	550
Route 3	North of Route 1	20,333	1.43%	290	27,377	3.85%	1,054
Route 1	East of Route 28	34,713	2.68%	931	35,272	3.18%	1,122
Chalan Lujuna	Between Route 1 and Route 15	4,599	3.34%	154	7,688	21.62%	1,662
Route 1	South of AAFB	19,064	2.36%	450	24,008	7.78%	1,868
Route 9	North of AAFB	7,332	2.17%	159	13,558	11.68%	1,584
Route 15	South of Chalan Lujuna	6,983	2.64%	185	7,816	6.65%	520
Route 1	North of Route 14A	69,492	2.85%	1982	70,263	3.40%	2,389

* In 2021 the Finegayan NWF Scenario represents both the Preferred Scenario and the Worst Case Scenario
Source: Parsons Brinckerhoff Planning, September 2013

Table 4-8. 2030 Average Daily Traffic, Heavy Vehicle Percentages and Number of Heavy Vehicles on Roadways within Study Area

Route	Segment	2030 No Build			2030 Build Finegayan NWF			2030 Build Barrigada NWF		
		ADT	% of Heavy Vehicles	Number of Heavy Vehicles	ADT	% of Heavy Vehicles	Number of Heavy Vehicles	ADT	% of Heavy Vehicles	Number of Heavy Vehicles
Route 1	South of Route 6	25,845	2.42%	624	27,167	2.42%	656	27,883	2.42%	673
Route 11	West of Route 1	3,446	13.95%	481	3,431	13.95%	479	3,434	13.95%	479
Route 1	West of Route 7	30,382	3.61%	1097	31,673	3.61%	1144	32,430	3.61%	1,171
Route 4	North of Route 7A	23,687	2.11%	501	23,692	2.11%	501	23,819	2.11%	503
Route 1	East of Route 4	48,319	2.47%	1192	49,533	2.47%	1222	49,740	2.47%	1,227
Route 8	West of Chalan RS Sanchez	28,477	1.19%	340	28,510	1.19%	340	31,764	1.19%	379
Route 16	Between 8 and 10A	31,826	1.72%	548	32,326	1.72%	556	34,091	1.72%	587
Route 27	Between Route 16 and Route 1	35,700	1.32%	471	35,985	1.32%	475	35,786	1.32%	472
Route 1	North of Pale San Vitores Road	45,877	2.31%	1060	47,664	2.31%	1101	46,111	2.31%	1,065
Route 16	South of Route 1	24,014	2.36%	568	24,355	2.36%	576	24,557	2.36%	580
Route 3	North of Route 1	21,499	1.43%	307	25,781	1.43%	368	21,990	1.43%	314
Route 1	East of Route 28	35,943	2.68%	964	35,958	2.68%	965	36,073	2.68%	968
Chalan Lujuna	Between Route 1 and Route 15	4,999	3.34%	167	5,092	3.34%	170	6,446	3.34%	215
Route 1	South of AAFB	19,861	2.36%	469	21,179	2.36%	500	21,740	2.36%	513
Route 9	North of AAFB	7,755	2.17%	168	10,774	2.17%	234	8,016	2.17%	174
Route 15	South of Chalan Lujuna	7,536	2.64%	199	7,657	2.64%	202	9,657	2.64%	255
Route 1	North of Route 14A	68,960	2.85%	1967	70,097	2.85%	2000	69,359	2.85%	1,979

Source: Parsons Brinckerhoff Planning, September 2013

The LOS of 65 intersections within the study area were analyzed to determine the traffic impacts due to the project. If the project causes a deterioration in the LOS of a congested intersection (defined as an intersection with a LOS of D or lower), the project is adversely affecting the intersection. The LOS for the intersections analyzed under the 2021 Finegayan scenario, which represents both the worst case scenario and the preferred scenario, along with the LOS for these intersections under the no build scenario are shown in Table 4-9 and Table 4-10. During the AM peak period, 14 congested intersections are predicted to experience a deterioration in LOS. During the PM peak period, eight congested intersections are predicted to experience a deterioration in LOS due to the project.

The LOS for the intersections analyzed under the 2030 Finegayan scenario (preferred scenario) and the 2030 Barrigada scenario (worst case scenario), along with the LOS for these intersections under the 2030 no build scenario are shown in Table 4-11 and Table 4-12. Under the Finegayan scenario, eight congested intersections in the AM peak period and 4 congested intersections in the PM peak period are predicted to experience a deterioration in LOS due to the project. Under the Barrigada scenario, seven congested intersections in the AM peak period and four congested intersections in the PM peak period are predicted to experience a deterioration in LOS due to the project. This deterioration, however, is not due to a significant increase in diesel vehicles, as it is predicted that the percentage of diesel vehicles will not increase due to the project, as per the traffic analyses conducted based on data from the Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report, Parsons Brinckerhoff, September 2013. The remaining scenarios demonstrated a similar pattern and are also not predicted to have an increase in percentage of diesel vehicles due to the project.

As the scenarios are not expected to significantly increase the number of diesel vehicles within the study area, nor are they expected to deteriorate the LOS at intersections within the study area due to a significant increase in diesel vehicles, the scenarios do not meet the criteria for a project of air quality concern, and therefore do not require a quantitative analysis and this element of the project is not predicted to cause an exceedance of the applicable NAAQS .

Table 4-9. 2021 AM Intersection Level of Service (LOS)

Intersection			2021 No Build	2021 Finegayan /NWF
Number	Location	Control	LOS	LOS
North Region				
1	Route 3 / Route 3A	TWSC	C	E
2	Route 3/9 / Chalan Santa Anita	TWSC	D	F
3	Route 9 / Route 3A	TWSC	B	F
4	Route 3 / Bullard Avenue	TWSC	C	- [3]
5	Route 3 / Route 28	Signalized	C	F
6	Route 3 / Royal Palm Drive	TWSC	D	F
7	Route 1/9 / AAFB Entrance	Signalized	B	B
8	Route 1 / Route 29	Signalized	C	D
9	Route 15 / Route 29	TWSC	F	F
10	Route 1 / Chalan Lajuna	Signalized	B	C
11	Route 15 / Chalan Lajuna	TWSC	F	F
12	Route 1 / Route 3	Signalized	F	F
13	Route 1 / Route 16	Signalized	C	D
14	Route 1 / Route 14 (Pale San Vitores)	Signalized	E	E
15	Route 16 / Route 27A	Signalized	B	B
16	Route 1 / Route 27A	Signalized	D	D
17	Route 28 / Route 27A	AWSC	B	B
18	Route 1 / Route 27	Signalized	E	E
19	Route 1 / Route 26	Signalized	C	C
20	Route 1 / Route 28	Signalized	D	E
21	Route 16 / Route 27	Signalized	F	F
61	Route 3 / USMC Main Gate	Signalized	- [4]	D
62	Route 3 / USMC Secondary Gate	Signalized	- [4]	E
63	Route 9 / AAFB North Gate	TWSC	- [5]	C
64	Route 16 / USMC Secondary Gate	Signalized	- [3]	- [4]
Central Region				
65	Route 15 / USMC Main Gate	Signalized	- [3]	- [4]
22	Route 16 / Route 10A	Signalized	F	F
23	Route 26 / Route 25	Signalized	C	C
24	Route 15 / Route 26	TWSC	F	F
25	Route 10A / Sunset Blvd (Airport)	Signalized	D	D
26	Route 1 / Route 14A	Signalized	C	D
27	Route 1 / Route 10A	Signalized	D	D
28	Route 1 / Route 14B	Signalized	C	C
29	Route 1 / Route 14	Signalized	E	F
30	Route 1 / Route 30	Signalized	D	E
31	Route 1 / Route 6 (Adelup)	Signalized	B	B
32	Route 1 / Route 4	Signalized	B	B
33	Route 1 / Route 8	Signalized	B	B
34	Route 8 / Chalan Santo Papa	TWSC	F	F
35	Route 8 / Route 7A	Signalized	B	B
36	Route 4 / Chalan Santo Papa	Signalized	C	C
37	Route 4 / Route 7A	Signalized	D	D

Table 4-9. 2021 AM Intersection Level of Service (LOS) (continued)

Intersection			2021 No Build	2021 Finegayan /NWF
Number	Location	Control	LOS	LOS
Central Region (cont'd)				
38	Route 4 / Route 7B	TWSC	D	D
39	Route 7A / Route 7	Signalized	C	C
40	Route 8 / Sunset Blvd	TWSC	-[4]	-[3]
41	Route 8 / Route 33	Signalized	D	D
42	Route 8 / Route 10	Signalized	C	C
43	Route 16 / Route 8A	Signalized	B	B
44	Route 10 / Route 15	Signalized	D	D
45	Route 4 / Route 15	Signalized	E	F
46	Route 4 / Route 10	Signalized	D	D
47	Route 1 / Route 11	Signalized	B	B
48	Route 1 / Route 6 (Veterans Cemetery)	Signalized	B	A
49	Route 1 / Polaris Point	Signalized	B	B
58	Tiyan Parkway / Route 10A	Signalized	D	D
59	Tiyan Parkway / Route 8	Signalized	B	B
60	Route 1 / Route 27 Extension	Signalized	D	D
South Region				
50	Route 1 / Route 2A	Signalized	B	B
51	Route 2A / Route 5	Signalized	C	C
52	Route 2 / Route 12	Signalized	C	C
53	Route 17 / Route 5	TWSC	C	C
54	Route 12 / Naval Magazine Entrance	TWSC	A	A
55	Route 17 / Route 4A	TWSC	C	C
56	Route 4 / Route 17	Signalized	E	E
57	Route 4 / Route 4A	TWSC	C	C

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report.

Notes:
LOS – level of service
TWSC – two-way stop-controlled
AWSC – all-way stop-controlled
[1] Average intersection delay in seconds per vehicle for signalized intersections.
[2] Average delay for worst-case movement in seconds per vehicle for unsignalized intersections.
[3] Intersection does not exist in evaluated alternative.
[4] Intersection does not exist in Year 2021 No Build conditions.
[5] ACE Gate assumed to remain closed in Year 2021 No Build conditions.

Table 4-10. 2021 PM Intersection Level of Service (LOS)

Intersection			2021 No Build	2021 Finegayan /NWF
Number	**Location**	**Control**	**LOS**	**LOS**
North Region				
1	Route 3 / Route 3A	TWSC	B	C
2	Route 3/9 / Chalan Santa Anita	TWSC	B	E
3	Route 9 / Route 3A	TWSC	B	F
4	Route 3 / Bullard Avenue	TWSC	B	- [3]
5	Route 3 / Route 28	Signalized	C	C
6	Route 3 / Royal Palm Drive	TWSC	B	C
7	Route 1/9 / AAFB Entrance	Signalized	B	B
8	Route 1 / Route 29	Signalized	C	C
9	Route 15 / Route 29	TWSC	D	D
10	Route 1 / Chalan Lajuna	Signalized	B	B
11	Route 15 / Chalan Lajuna	TWSC	E	F
12	Route 1 / Route 3	Signalized	D	F
13	Route 1 / Route 16	Signalized	E	F
14	Route 1 / Route 14 (Pale San Vitores)	Signalized	D	D
15	Route 16 / Route 27A	Signalized	B	B
16	Route 1 / Route 27A	Signalized	D	D
17	Route 28 / Route 27A	AWSC	F	F
18	Route 1 / Route 27	Signalized	D	E
19	Route 1 / Route 26	Signalized	D	D
20	Route 1 / Route 28	Signalized	D	D
21	Route 16 / Route 27	Signalized	F	F
61	Route 3 / USMC Main Gate	Signalized	- [4]	D
62	Route 3 / USMC Secondary Gate	Signalized	- [4]	C
63	Route 9 / AAFB North Gate	TWSC	- [5]	B
64	Route 16 / USMC Secondary Gate	Signalized	- [3]	- [4]
Central Region				
65	Route 15 / USMC Main Gate	Signalized	- [3]	- [4]
22	Route 16 / Route 10A	Signalized	D	D
23	Route 26 / Route 25	Signalized	A	A
24	Route 15 / Route 26	TWSC	F	F
25	Route 10A / Sunset Blvd (Airport)	Signalized	C	C
26	Route 1 / Route 14A	Signalized	F	F
27	Route 1 / Route 10A	Signalized	F	F
28	Route 1 / Route 14B	Signalized	C	D
29	Route 1 / Route 14	Signalized	D	E
30	Route 1 / Route 30	Signalized	D	D
31	Route 1 / Route 6 (Adelup)	Signalized	C	C
32	Route 1 / Route 4	Signalized	B	B
33	Route 1 / Route 8	Signalized	C	C
34	Route 8 / Chalan Santo Papa	TWSC	F	F
35	Route 8 / Route 7A	Signalized	C	C
36	Route 4 / Chalan Santo Papa	Signalized	D	D
37	Route 4 / Route 7A	Signalized	D	D
38	Route 4 / Route 7B	TWSC	F	F
39	Route 7A / Route 7	Signalized	C	C

Table 4-10. 2021 PM Intersection Level of Service (LOS) (continued)

Intersection			2021 No Build	2021 Finegayan /NWF
Number	**Location**	**Control**	**LOS**	**LOS**
Central Region (Cont'd)				
40	Route 8 / Sunset Blvd	TWSC	- [4]	- [3]
41	Route 8 / Route 33	Signalized	C	C
42	Route 8 / Route 10	Signalized	D	D
43	Route 16 / Route 8A	Signalized	A	A
44	Route 10 / Route 15	Signalized	C	C
45	Route 4 / Route 15	Signalized	D	D
46	Route 4 / Route 10	Signalized	D	D
47	Route 1 / Route 11	Signalized	B	B
48	Route 1 / Route 6 (Veterans Cemetery)	Signalized	B	B
49	Route 1 / Polaris Point	Signalized	B	B
58	Tiyan Parkway / Route 10A	Signalized	D	D
59	Tiyan Parkway / Route 8	Signalized	A	A
60	Route 1 / Route 27 Extension	Signalized	- [4]	- [3]
South Region				
50	Route 1 / Route 2A	Signalized	C	C
51	Route 2A / Route 5	Signalized	B	B
52	Route 2 / Route 12	Signalized	B	B
53	Route 17 / Route 5	TWSC	B	B
54	Route 12 / Naval Magazine Entrance	TWSC	A	A
55	Route 17 / Route 4A	TWSC	C	C
56	Route 4 / Route 17	Signalized	B	C
57	Route 4 / Route 4A	TWSC	B	B

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report..

Notes:

LOS – level of service

TWSC – two-way stop-controlled

AWSC – all-way stop-controlled

[1] Average intersection delay in seconds per vehicle for signalized intersections.

[2] Average delay for worst-case movement in seconds per vehicle for unsignalized intersections.

[3] Intersection does not exist in evaluated alternative.

[4] Intersection does not exist in Year 2021 No Build conditions.

[5] ACE Gate assumed to remain closed in Year 2021 No Build conditions.

Table 4-11. 2030 AM Intersection Level of Service (LOS)

Intersection			2030 No Build	2030 Finegayan /NWF	2030 Barrigada /NWF
Number	Location	Control	LOS	LOS	LOS
North Region					
1	Route 3 / Route 3A	TWSC	C	D	C
2	Route 3/9 / Chalan Santa Anita	TWSC	E	F	E
3	Route 9 / Route 3A	TWSC	B	C	B
4	Route 3 / Bullard Avenue	TWSC	C	C	C
5	Route 3 / Route 28	Signalized	C	D	D
6	Route 3 / Royal Palm Drive	TWSC	E	F	E
7	Route 1/9 / AAFB Entrance	Signalized	B	B	B
8	Route 1 / Route 29	Signalized	C	C	C
9	Route 15 / Route 29	TWSC	F	F	F
10	Route 1 / Chalan Lajuna	Signalized	B	C	C
11	Route 15 / Chalan Lajuna	TWSC	F	F	F
12	Route 1 / Route 3	Signalized	F	F	F
13	Route 1 / Route 16	Signalized	C	C	C
14	Route 1 / Route 14 (Pale San Vitores)	Signalized	C	D	C
15	Route 16 / Route 27A	Signalized	C	C	C
16	Route 1 / Route 27A	Signalized	D	D	D
17	Route 28 / Route 27A	AWSC	B	B	B
18	Route 1 / Route 27	Signalized	F	F	F
19	Route 1 / Route 26	Signalized	C	D	D
20	Route 1 / Route 28	Signalized	D	D	E
21	Route 16 / Route 27	Signalized	F	F	F
61	Route 3 / USMC Main Gate	Signalized	- [3]	D	- [4]
62	Route 3 / USMC Secondary Gate	Signalized	- [3]	B	- [4]
63	Route 9 / AAFB North Gate	TWSC	- [3]	C	B
64	Route 16 / USMC Secondary Gate	Signalized	- [3]	- [4]	A
65	Route 15 / USMC Main Gate	Signalized	- [3]	- [4]	C
Central Region					
22	Route 16 / Route 10A	Signalized	F	F	F
23	Route 26 / Route 25	Signalized	C	C	C
24	Route 15 / Route 26	TWSC	F	F	F
25	Route 10A / Sunset Blvd (Airport)	Signalized	C	C	C
26	Route 1 / Route 14A	Signalized	D	D	D
27	Route 1 / Route 10A	Signalized	D	D	D
28	Route 1 / Route 14B	Signalized	D	D	D
29	Route 1 / Route 14	Signalized	E	E	E
30	Route 1 / Route 30	Signalized	E	E	E
31	Route 1 / Route 6 (Adelup)	Signalized	B	B	B
32	Route 1 / Route 4	Signalized	B	B	B
33	Route 1 / Route 8	Signalized	B	B	B
34	Route 8 / Chalan Santo Papa	TWSC	F	F	F
35	Route 8 / Route 7A	Signalized	B	C	C
36	Route 4 / Chalan Santo Papa	Signalized	C	C	C
37	Route 4 / Route 7A	Signalized	D	D	E

Table 4-11. 2030 AM Intersection Level of Service (LOS) (continued)

Intersection			2030 No Build	2030 Finegayan /NWF	2030 Barrigada /NWF
Number	**Location**	**Control**	**LOS**	**LOS**	**LOS**
Central Region (cont'd)					
38	Route 4 / Route 7B	TWSC	D	E	E
39	Route 7A / Route 7	Signalized	C	C	C
40	Route 8 / Sunset Blvd	TWSC	- [3]	- [3]	- [3]
41	Route 8 / Route 33	Signalized	D	D	D
42	Route 8 / Route 10	Signalized	C	C	C
43	Route 16 / Route 8A	Signalized	B	B	B
44	Route 10 / Route 15	Signalized	D	D	E
45	Route 4 / Route 15	Signalized	E	E	E
46	Route 4 / Route 10	Signalized	E	E	E
47	Route 1 / Route 11	Signalized	B	B	B
48	Route 1 / Route 6 (Veterans Cemetery)	Signalized	A	A	A
49	Route 1 / Polaris Point	Signalized	B	B	B
58	Tiyan Parkway / Route 10A	Signalized	C	C	D
59	Tiyan Parkway / Route 8	Signalized	E	E	E
60	Route 1 / Route 27 Extension	Signalized	B	C	C
South Region					
50	Route 1 / Route 2A	Signalized	B	B	B
51	Route 2A / Route 5	Signalized	C	C	C
52	Route 2 / Route 12	Signalized	C	C	C
53	Route 17 / Route 5	TWSC	D	D	D
54	Route 12 / Naval Magazine Entrance	TWSC	A	A	A
55	Route 17 / Route 4A	TWSC	C	C	C
56	Route 4 / Route 17	Signalized	E	E	E
57	Route 4 / Route 4A	TWSC	C	C	C

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report.

Notes:
LOS – level of service
TWSC – two-way stop-controlled
AWSC – all-way stop-controlled
[1] Average intersection delay in seconds per vehicle for signalized intersections.
[2] Average delay for worst-case movement in seconds per vehicle for unsignalized intersections.
[3] Intersection does not exist in Year 2030 No Build conditions.
[4] Intersection does not exist in evaluated scenario.

Table 4-12. 2030 PM Intersection Level of Service (LOS)

Intersection			2030 No Build	2030 Finegayan /NWF	2030 Barrigada /NWF
Number	Location	Control	LOS	LOS	LOS
North Region					
1	Route 3 / Route 3A	TWSC	B	C	B
2	Route 3/9 / Chalan Santa Anita	TWSC	B	D	C
3	Route 9 / Route 3A	TWSC	B	C	C
4	Route 3 / Bullard Avenue	TWSC	B	C	B
5	Route 3 / Route 28	Signalized	C	C	C
6	Route 3 / Royal Palm Drive	TWSC	B	C	B
7	Route 1/9 / AAFB Entrance	Signalized	C	C	C
8	Route 1 / Route 29	Signalized	C	C	C
9	Route 15 / Route 29	TWSC	D	D	D
10	Route 1 / Chalan Lajuna	Signalized	B	B	B
11	Route 15 / Chalan Lajuna	TWSC	F	F	F
12	Route 1 / Route 3	Signalized	E	F	E
13	Route 1 / Route 16	Signalized	D	E	D
14	Route 1 / Route 14 (Pale San Vitores)	Signalized	D	D	D
15	Route 16 / Route 27A	Signalized	B	B	B
16	Route 1 / Route 27A	Signalized	D	D	D
17	Route 28 / Route 27A	AWSC	F	F	F
18	Route 1 / Route 27	Signalized	D	D	E
19	Route 1 / Route 26	Signalized	F	F	F
20	Route 1 / Route 28	Signalized	D	D	D
21	Route 16 / Route 27	Signalized	F	F	F
61	Route 3 / USMC Main Gate	Signalized	-[3]	C	-[4]
62	Route 3 / USMC Secondary Gate	Signalized	-[3]	A	-[4]
63	Route 9 / AAFB North Gate	TWSC	-[3]	B	B
64	Route 16 / USMC Secondary Gate	Signalized	-[3]	-[4]	A
65	Route 15 / USMC Main Gate	Signalized	-[3]	-[4]	B
Central Region					
22	Route 16 / Route 10A	Signalized	D	D	D
23	Route 26 / Route 25	Signalized	A	A	A
24	Route 15 / Route 26	TWSC	F	F	F
25	Route 10A / Sunset Blvd (Airport)	Signalized	D	E	D
26	Route 1 / Route 14A	Signalized	F	F	F
27	Route 1 / Route 10A	Signalized	F	F	F
28	Route 1 / Route 14B	Signalized	C	C	C
29	Route 1 / Route 14	Signalized	D	D	D
30	Route 1 / Route 30	Signalized	D	D	D
31	Route 1 / Route 6 (Adelup)	Signalized	C	C	C
32	Route 1 / Route 4	Signalized	B	B	B
33	Route 1 / Route 8	Signalized	B	B	C
34	Route 8 / Chalan Santo Papa	TWSC	F	F	F
35	Route 8 / Route 7A	Signalized	E	E	E
36	Route 4 / Chalan Santo Papa	Signalized	D	D	D
37	Route 4 / Route 7A	Signalized	D	D	E
38	Route 4 / Route 7B	TWSC	F	F	F
39	Route 7A / Route 7	Signalized	C	C	C

Table 4-12. 2030 PM Intersection Level of Service (LOS) (continued)

Intersection			2030 No Build	2030 Finegayan /NWF	2030 Barrigada /NWF
Number	**Location**	**Control**	**LOS**	**LOS**	**LOS**
Central Region (cont'd)					
40	Route 8 / Sunset Blvd	TWSC	—[3]	—[3]	—[3]
41	Route 8 / Route 33	Signalized	B	B	B
42	Route 8 / Route 10	Signalized	C	C	C
43	Route 16 / Route 8A	Signalized	A	A	A
44	Route 10 / Route 15	Signalized	C	C	E
45	Route 4 / Route 15	Signalized	D	D	D
46	Route 4 / Route 10	Signalized	D	D	E
47	Route 1 / Route 11	Signalized	B	B	B
48	Route 1 / Route 6 (Veterans Cemetery)	Signalized	B	B	B
49	Route 1 / Polaris Point	Signalized	A	A	A
58	Tiyan Parkway / Route 10A	Signalized	E	E	E
59	Tiyan Parkway / Route 8	Signalized	D	D	E
60	Route 1 / Route 27 Extension	Signalized	A	B	A
South Region					
50	Route 1 / Route 2A	Signalized	C	C	C
51	Route 2A / Route 5	Signalized	B	B	B
52	Route 2 / Route 12	Signalized	B	B	B
53	Route 17 / Route 5	TWSC	C	C	C
54	Route 12 / Naval Magazine Entrance	TWSC	A	A	A
55	Route 17 / Route 4A	TWSC	C	C	C
56	Route 4 / Route 17	Signalized	C	C	C
57	Route 4 / Route 4A	TWSC	B	B	B

Source: Parsons Brinckerhoff, September 2013, Guam and CNMI Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement (SEIS) Traffic Operations Report.

Notes:
LOS – level of service
TWSC – two-way stop-controlled
AWSC – all-way stop-controlled
[1] Average intersection delay in seconds per vehicle for signalized intersections.
[2] Average delay for worst-case movement in seconds per vehicle for unsignalized intersections.
[3] Intersection does not exist in Year 2030 No Build conditions.
[4] Intersection does not exist in evaluated scenario.

4.4 LOCAL CO ASSESSMENT AND CONFORMITY ANALYSIS

Maximum one hour and eight hour CO levels were predicted at receptor sites along the preferred and worst case scenarios. The year 2030 represents the design year for the proposed scenarios. 2021 represents the peak construction year for the proposed scenarios. Maximum existing (2012), 2021 and 2030 one hour CO concentrations are shown in Table 4-13. Maximum eight hour existing (2012), 2021 and 2030 CO concentrations are shown in Table 4-14. The CO levels estimated by the model are the maximum concentrations that could be expected to occur at each air quality receptor site analyzed. This assumes simultaneous occurrence of a number of worst case conditions: peak hour traffic conditions, conservative vehicular operating conditions, low wind speed, low atmospheric temperature, neutral atmospheric conditions, and maximizing wind direction. The remaining scenarios are expected to show similar or slightly lower CO levels since they have similar or lower volumes and LOS.

Based on the eight-hour values presented in Table 4-14, the Finegayan NWF Scenario is predicted to slightly increase CO levels at two locations and have no meaningful affect at four locations in 2021 (peak construction year), when compared to the No-Build Scenario.

In 2030, the Finegayan NWF Scenario is predicted to slightly increase CO levels at two locations and have no meaningful affect at four locations, when compared to the No-Build Scenario. In 2030, the Barrigada NWF Scenario is predicted to slightly increase CO levels at two locations and have no meaningful affect at four locations, when compared to the No-Build Scenario.

At the locations selected for detailed analysis, there is a potential for CO levels to be higher with the Build Scenarios as compared to the No-Build Scenario. This is because only those intersections demonstrating a reduced LOS or increased volume under the Build Scenarios were analyzed to ensure that the project does not cause or exacerbate a violation of an applicable standard. No violations of the NAAQS are predicted for either of the future analysis years. The CAL3QHC Version 2 input and output data for each site is contained in Appendix A (electronic).

In summary, a microscale CO analysis was conducted on a series of scenarios to determine if any have the potential to cause or exacerbate a violation of the applicable CO standards. The result of this analysis, which was conducted following USEPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (USEPA, 1992a), is that the scenarios are not predicted to cause or exacerbate a violation of the NAAQS for CO.

Table 4-13. Predicted Worst Case One-Hour Existing (2012), 2021 and 2030 CO Concentrations (ppm)

Site #	Site Description	2012 Existing		2021 No Build		2021 Finegayan NWF		2030 No Build		2030 Finegayan NWF		2030 Barrigada NWF	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
North Region													
1	Route 3/9/Chalan Santa Anita	2.3	2.2	2.2	2.1	2.4	2.3	2.2	2.1	2.3	2.3	2.2	2.2
2	Route 1 / Route 3	4.4	4.0	3.6	3.2	3.6	3.3	3.4	3.1	3.4	3.2	3.4	3.1
3	Route 16 / Route 27	4.0	3.7	2.9	3.0	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Central Region													
4	Route 1 / Route 14A	3.9	4.7	3.1	3.8	3.2	3.8	3.1	3.6	3.1	3.7	3.1	3.6
5	Route 10 / Route 15	3.7	4.8	2.8	2.8	2.8	2.9	2.8	2.8	2.8	2.9	3.2	2.8
South Region													
6	Route 1 / Route 2A	2.8	2.6	2.4	2.4	2.5	2.4	3.0	3.0	3.0	3.0	3.0	3.0

Notes: Concentrations = modeled results + 1-hour CO background.
1-hour CO background = 2.0 ppm; 1-hour CO standard = 35 ppm.
AM = morning; PM = evening; ppm = parts per million.

Table 4-14. Predicted Worst Case Eight Hour Existing (2012), 2021 and 2030 CO Concentrations (ppm)

Site #	Site Description	2012 Existing	2021		2030		
			No Build	Finegayan NWF	No Build	Finegayan NWF	Barrigada NWF
North Region							
1	Route 3/9/Chalan Santa Anita	2.2	2.1	2.3	2.1	2.2	2.1
2	Route 1 / Route 3	3.7	3.1	3.1	3.0	3.0	3.0
3	Route 16 / Route 27	3.4	2.7	2.7	2.7	2.7	2.7
Central Region							
4	Route 1 / Route 14A	3.9	3.3	3.3	3.1	3.2	3.1
5	Route 10 / Route 15	4.0	2.6	2.6	2.6	2.6	2.8
South Region							
6	Route 1 / Route 2A	2.6	2.3	2.4	2.3	2.3	2.4

Notes: Concentrations = (modeled results x persistence factor [0.7]) + 8-hour CO background.
8-hour CO background = 2.0 ppm; 8-hour CO standard = 9 ppm.
Abbreviations: ppm = parts per million.

4.5 MSAT Assessment

The screening-level MSAT dispersion modeling analysis was conducted at sensitive (actual) and sidewalk receptors. The results of this analysis are shown in Table 4-15 and Table 4-16 for the Finegayan NWF Scenario and Table 4-17 and Table 4-18 for the Barrigada NWF Scenario. The remaining scenarios are expected to show similar or slightly lower MSAT levels since they have similar or lower volumes and LOS. Based on these results, the following conclusions can be made:

- Cancer and non-cancer risks at the actual sensitive receptors are substantially lower than the values estimated at the sidewalk receptors;
- Maximum estimated increases in cancer risk at any of the receptors due to the project are all less than the threshold criteria of 10 in a million. Therefore, the project impacts of all carcinogenic MSATs are considered acceptable;
- Applying a more conservative exposure duration of 70 years, rather than 30 years, would not cause the maximum estimated increases in cancer risk at any of the receptors to increase over the threshold of 10 in a million; and
- Maximum estimated increases in the total chronic hazard index at any of the receptors due to the project are all less than the threshold limit of 1. Therefore, the project impacts of all non-carcinogenic MSATs are considered acceptable.
- In addition, based on proposed USEPA regulations to reduce air toxics, future cancer and non-cancer risks under the No Build and Build scenarios are less than existing risks in most cases.

Table 4-15. Estimated Project Related Impacts Compared to Cancer Risk Threshold Finegayan NWF Scenario

Receptor Type	Analysis Site	30-Year Estimated Cancer Risk Increase or Decrease ($x10^{-6}$)		70-Year Estimated Cancer Risk Increase or Decrease ($x10^{-6}$)		Cancer Risk Threshold
		2021	2030	2021	2030	
Sensitive Receptors	North Region					10
	Route 3/9/Chalan Santa Anita	.147	0.023	.353	0.056	
	Route 1 / Route 3	.032	0.012	.076	0.028	
	Route 16 / Route 27	.041	0.006	.098	0.015	
	South Region					
	Route 1 / Route 14A	.011	0.002	.026	0.005	
	Route 10 / Route 15	.002	0.010	.004	0.023	
	Central Region					
	Route 1 / Route 2A	.011	0.001	.027	0.002	
Sidewalk Receptors	North Region					10
	Route 3/9/Chalan Santa Anita	.075	0.037	.180	0.088	
	Route 1 / Route 3	.035	0.030	.084	0.071	
	Route 16 / Route 27	.033	0.007	.078	0.016	
	South Region					
	Route 1 / Route 14A	.037	0.008	.089	0.019	
	Route 10 / Route 15	.070	0.125	.168	0.300	
	Central Region					
	Route 1 / Route 2A	.024	0.003	.057	0.006	

Table 4-16. Estimated Project Related Impacts Compared to Hazard Index, Finegayan NWF Scenario

Receptor Type	Analysis Site	30-Year Estimated Non-Cancer Chronic Hazard Index Increase or Decrease		USEPA Target Hazard Index
		2021	2030	
Sensitive Receptors	North Region			1
	Route 3/9/Chalan Santa Anita	.030	0.003	
	Route 1 / Route 3	.008	0.002	
	Route 16 / Route 27	.015	0.001	
	South Region			
	Route 1 / Route 14A	.003	0.000	
	Route 10 / Route 15	.005	0.002	
	Central Region			
	Route 1 / Route 2A	.004	0.000	
Sidewalk Receptors	North Region			1
	Route 3/9/Chalan Santa Anita	.015	0.005	
	Route 1 / Route 3	.012	0.004	
	Route 16 / Route 27	.013	0.001	
	South Region			
	Route 1 / Route 14A	.011	0.001	
	Route 10 / Route 15	.018	0.018	
	Central Region			
	Route 1 / Route 2A	.007	0.001	

Table 4-17. Estimated Project Related Impacts Compared to Cancer Risk Threshold, Barrigada NWF Scenario

Receptor Type	Analysis Site	30-Year Estimated Cancer Risk Increase or Decrease ($x10^{-6}$) 2030	70-Year Estimated Cancer Risk Increase or Decrease ($x10^{-6}$) 2030	Cancer Risk Threshold
Sensitive Receptors	North Region			10
	Route 3/9/Chalan Santa Anita	0.000	0.001	
	Route 1 / Route 3	0.004	0.010	
	Route 16 / Route 27	0.020	0.049	
	Central Region			
	Route 1 / Route 14A	0.002	0.006	
	Route 10 / Route 15	0.045	0.107	
	South Region			
	Route 1 / Route 2A	0.006	0.014	
Sidewalk Receptors	North Region			10
	Route 3/9/Chalan Santa Anita	0.004	0.009	
	Route 1 / Route 3	0.010	0.024	
	Route 16 / Route 27	0.022	0.053	
	Central Region			
	Route 1 / Route 14A	0.008	0.020	
	Route 10 / Route 15	0.146	0.350	
	South Region			
	Route 1 / Route 2A	0.012	0.029	

Table 4-18. Estimated Project Related Impacts Compared to Hazard Index, Barrigada NWF Scenario

Receptor Type	Analysis Site	30-Year Estimated Non-Cancer Chronic Hazard Index Increase or Decrease 2030	USEPA Target Hazard Index
Sensitive Receptors	North Region		1
	Route 3/9/Chalan Santa Anita	0.000	
	Route 1 / Route 3	0.001	
	Route 16 / Route 27	0.004	
	Central Region		
	Route 1 / Route 14A	0.000	
	Route 10 / Route 15	0.008	
	South Region		
	Route 1 / Route 2A	0.001	
Sidewalk Receptors	North Region		1
	Route 3/9/Chalan Santa Anita	0.000	
	Route 1 / Route 3	0.002	
	Route 16 / Route 27	0.004	
	Central Region		
	Route 1 / Route 14A	0.002	
	Route 10 / Route 15	0.022	
	South Region		
	Route 1 / Route 2A	0.003	

4.6 GREENHOUSE GASES

Under NEPA, detailed environmental analysis should be focused on issues that are significant and meaningful to decision-making.[5] FHWA has concluded, based on the nature of GHG emissions and the exceedingly small potential GHG impacts of the preferred and worst case scenarios, as discussed below and shown in Table 4-19, that the GHG emissions from the proposed action will not result in "reasonably foreseeable significant adverse impacts on the human environment" (40 CFR 1502.22(b)). The GHG emissions from the project build scenarios will be insignificant, and will not play a meaningful role in a determination of the environmentally preferable scenario or the selection of the preferred scenario. More detailed information on GHG emissions "is not essential to a reasoned choice among reasonable scenarios" (40 CFR 1502.22(a)) or to making a decision in the best overall public interest based on a balanced consideration of transportation, economic, social, and environmental needs and impacts (23 CFR 771.105(b)). As such, it is expected that the results presented in Table 4-19 are representative for all project scenarios.

The context in which the emissions from the scenarios will occur, together with the expected GHG emissions contribution from them, illustrate why the project's GHG emissions will not be significant and will not be a substantial factor in the decision-making. The transportation sector is the second largest source of total GHG emissions in the U.S., behind electricity generation. The transportation sector was responsible for approximately 27 percent of all anthropogenic (human caused) GHG emissions in the U.S. in 2010.6 The majority of transportation GHG emissions are the result of fossil fuel combustion. CO2 makes up the largest component of these GHG emissions. U.S. CO2 emissions from the consumption of

[5] *See* 40 CFR 1500.1(b), 1500.2(b), 1500.4(g), and 1501.7
[6] Calculated from data in U.S. Environmental Protection Agency, Inventory of Greenhouse Gas Emissions and Sinks, 1990-2010.

energy accounted for about 18 percent of worldwide energy consumption CO2 emissions in 2010.7. U.S. transportation CO2 emissions accounted for about 6 percent of worldwide CO2 emissions.8

While the contribution of GHGs from transportation in the U.S. as a whole is a large component of U.S. GHG emissions, as the scale of analysis is reduced the GHG contributions become quite small. Using CO2 because of its predominant role in GHG emissions, Table 4-19 presents the relationship between current and projected Guam highway CO2 emissions and total global CO2 emissions, as well as information on the scale of the project relative to statewide travel activity.

Table 4-19. Project Emissions Potential, Relative to Global Totals

	Global CO_2 emissions, MMT[9]	Guam motor vehicle CO_2 emissions, MMT[10]	Guam motor vehicle emissions, % of global total	Percent change in VMT due to Finegayan NWF Scenario	Percent change in VMT due to Barrigada NWF Scenario
Current Conditions (2012)	29,670	0.454	0.0015%	(None)	(None)
Future Projection (2030)	39,260	0.385	0.0010%	3.19%	3.85%

Notes: MMT = million metric tons. Global emissions estimates are from International Energy Outlook 2010, data for Figure 104, projected to 2040. Guam emissions and statewide VMT estimates are based on MOVES2010b.

Based on emissions estimates from EPA's Motor Vehicle Emissions Simulator (MOVES) model[11], and global CO_2 estimates and projections from the Energy Information Administration, CO_2 emissions from motor vehicles in Guam contributed less than one-one hundredth of one percent of global emissions in 2012 (0.0015%). These emissions are projected to contribute an even smaller fraction (0.0010%) in 2030[12]. As a result of the proposed action, FHWA estimates that the Finegayan NWF Scenario could result in a potential increase in global CO_2 emissions in 2030 of 0.00003%. FHWA estimates that the Barrigada NWF Scenario could result in a potential increase in global CO_2 emissions in 2030 of 0.00004%. These very small changes in global emissions are well within the range of uncertainty associated with future emissions estimates.[13, 14] As such, neither of these alternatives will result in a change in Guam's share of global emissions in 2030, which are estimated to be 0.0010%.

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[7] Calculated from data in U.S. Energy Information Administration International Energy Statistics, Total Carbon Dioxide Emissions from the Consumption of Energy, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8, accessed 2/25/13.
[8] Calculated from data in EIA figure 104: http://www.eia.gov/forecasts/archive/ieo10/emissions.html and EPA table ES-3: : http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Executive-Summary.pdf
[9] These estimates are from the EIA's *International Energy Outlook 2010*, and are considered the best-available projections of emissions from fossil fuel combustion. These totals do not include other sources of emissions, such as cement production, deforestation, or natural sources; however, reliable future projections for these emissions sources are not available.
[10] MOVES projections suggest that Guam motor vehicle CO_2 emissions may decrease by 15% between 2012 and 2030; more stringent fuel economy/GHG emissions standards will offset projected growth in VMT. This analysis assumes that military vehicle fuel economy will improve at the same rate as that of the civilian vehicle fleet.
[11] http://www.epa.gov/otaq/models/moves/index.htm. EPA's MOVES model can be used to estimate vehicle exhaust emissions of carbon dioxide (CO_2) and other GHGs. CO_2 is frequently used as an indicator of overall transportation GHG emissions because the quantity of these emissions is much larger than that of all other transportation GHGs combined, and because CO_2 accounts for 90-95% of the overall climate impact from transportation sources.
[12] Guam emissions represent a smaller share of global emissions in 2030 because global emissions increase at a faster rate.
[13] For example, Figure 114 of the Energy Information Administration's *International Energy Outlook 2010* shows that future emissions projections can vary by almost 20%, depending on which scenario for future economic growth proves to be most accurate.
[14]When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency is required make clear that such information is

4.6.1 Mitigation for Global GHG Emissions

To help address the global issue of climate change, USDOT is committed to reducing GHG emissions from vehicles traveling on our nation's highways. USDOT and EPA are working together to reduce these emissions by substantially improving vehicle efficiency and shifting toward lower carbon intensive fuels. The agencies have jointly established new, more stringent fuel economy and first ever GHG emissions standards for model year 2012-2025 cars and light trucks, with an ultimate fuel economy standard of 54.5 miles per gallon for cars and light trucks by model year 2025. Further, on September 15, 2011, the agencies jointly published the first ever fuel economy and GHG emissions standards for heavy-duty trucks and buses.[15] Increasing use of technological innovations that can improve fuel economy, such as gasoline- and diesel-electric hybrid vehicles, will improve air quality and reduce CO_2 emissions future years.

Consistent with its view that broad-scale efforts hold the greatest promise for meaningfully addressing the global climate change problem, FHWA is engaged in developing strategies to reduce transportation's contribution to GHGs—particularly CO_2 emissions—and to assess the risks to transportation systems and services from climate change. In an effort to assist States and MPOs in performing GHG analyses, FHWA has developed a *Handbook for Estimating Transportation GHG Emissions for Integration into the Planning Process.* The Handbook presents methodologies reflecting good practices for the evaluation of GHG emissions at the transportation program level, and will demonstrate how such evaluation may be integrated into the transportation planning process. FHWA has also developed a tool for use at the statewide level to model a large number of GHG reduction scenarios and scenarios for use in transportation planning, climate action plans, scenario planning exercises, and in meeting state GHG reduction targets and goals. To assist states and MPOs in assessing climate change vulnerabilities to their transportation networks, FHWA has developed a draft vulnerability and risk assessment conceptual model and has piloted it in several locations.

At the State level, project planning activities are key to reducing GHG from highway projects, and mitigation of GHGs. To this end, the island of Guam has set a goal to reduce petroleum use 20% by 2020[16]. Since transportation is responsible for one-third of Guam's on-island fossil fuel consumption, changes in this sector will be instrumental in achieving the 20% reduction goal. The reduction in use of fossil fuels will, in turn, contribute to a reduction in greenhouse gases from transportation on the island.

Even though project-level mitigation measures will not have a substantial impact on global GHG emissions because of the exceedingly small amount of GHG emissions involved, the following measures during construction will have the effect of reducing GHG emissions: use of newer, more fuel efficient equipment; reduced idling time of equipment; use of scenario fueled equipment, where applicable; carpooling to the work site. These activities are part of a program-wide effort by FHWA to adopt practical means to avoid and minimize environmental impacts in accordance with 40 CFR 1505.2(c).

lacking (40 CFR 1502.22). The methodologies for forecasting GHG emissions from transportation projects continue to evolve and the data provided should be considered in light of the constraints affecting the currently available methodologies. As previously stated, tools such as EPA's MOVES model can be used to estimate vehicle exhaust emissions of carbon dioxide (CO_2) and other GHGs. However, only rudimentary information is available regarding the GHG emissions impacts of highway construction and maintenance. Estimation of GHG emissions from vehicle exhaust is subject to the same types of uncertainty affecting other types of air quality analysis, including imprecise information about current and future estimates of vehicle miles traveled, vehicle travel speeds, and the effectiveness of vehicle emissions control technology. Finally, there presently is no scientific methodology that can identify causal connections between individual source emissions and specific climate impacts at a particular location.

[15] For more information on fuel economy proposals and standards, see the National Highway Traffic Safety Administration's Corporate Average Fuel Economy website: http://www.nhtsa.gov/fuel-economy/.

[16] According to National Renewable Energy Laboratory's (NREL) *Guam Transportation Petroleum-Use Reduction Plan,* April 2013. http://www.nrel.gov/docs/fy13osti/57191.pdf

4.6.2 Summary

This document does not incorporate an analysis of the GHG emissions or climate change effects of all of the scenarios because the potential change in GHG emissions is very small in the context of the affected environment. Because of the insignificance of the GHG impacts, those impacts will not be meaningful to a decision on the environmentally preferable scenario or to a choice among scenarios. As outlined above, FHWA is working to develop strategies to reduce transportation's contribution to GHGs—particularly CO_2 emissions—and to assess the risks to transportation systems and services from climate change. FHWA will continue to pursue these efforts as productive steps to address this important issue. Finally, the construction best practices described above represent practicable project-level measures that, while not substantially reducing global GHG emissions, may help reduce GHG emissions on an incremental basis and could contribute in the long term to meaningful cumulative reduction when considered across the Federal-aid highway program.

5 CONCLUSIONS

The effect of the Guam and CNMI Military Relocation (2012 Roadmap Adjustments) project on off-base roads is not predicted to cause or exacerbate a violation of the NAAQS. The potential cancer and chronic noncancer health risks associated with increased mobile source air toxics associated with roadway traffic and construction of the roadways are predicted to be below the applicable health risk guideline values. Furthermore, FHWA estimates that the Barrigada NWF Scenario could result in a potential increase in global CO_2 emissions in 2030 of 0.00004%, and a corresponding increase in Guam's share of global emissions in 2030 to 0.0010%. This very small change in global emissions is well within the range of uncertainty associated with future emissions estimates.

6 REFERENCES

Federal Highway Administration (FHWA). 2012. Interim Guidance Update on Air Toxic Analysis in NEPA Documents. December 6, 2012.

US Environmental Protection Agency (USEPA). 1992a. Guideline for Modeling Carbon Monoxide from Roadway Intersections, EPA-454/R-92-005. November 1992.

US Environmental Protection Agency (USEPA). 1992b. User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations near Roadway Intersections, EPA-454/R-92-006. Prepared by the Office of Air Quality Planning and Standards. November 1992.

US Environmental Protection Agency (USEPA). 2010. Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas, EPA-420-B-10-052. December 2010.

US Environmental Protection Agency (USEPA). 2012. Motor Vehicle Emissions Simulator (MOVES2010b), User Guide for MOVE2010b, Report EPA-420-B-12-001b. Assessment and Standards Division, Office of Transportation and Air Quality. Found at *http://www.epa.gov/otaq/models/moves/index.htm*. October 2012.

US Environmental Protection Agency (USEPA). 2012a. National Ambient Air Quality Standards (NAAQS). Office of Air and Radiation. Found at *http://www.epa.gov/air/criteria.html*. Updated August 2013.

US Environmental Protection Agency (USEPA). 2013. Human Health Risk Assessment Protocol (HHRAP). http://www.epa.gov/osw/hazard/tsd/td/combust/risk.htm, August 2013.

Appendix F.4

Noise

DEPARTMENT OF THE ARMY
US ARMY INSTITUTE OF PUBLIC HEALTH
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5403

MCHB-IP-EON JUN 27 2013

MEMORANDUM FOR Naval Facilities Engineering Command, Pacific (Environmental Planning Division/Mr. Ian Beltran), 258 Makalapa Drive, Suite 100, Joint Base Pearl Harbor-Hickam, HI 96860-3134

SUBJECT: Operational Noise Consultation, No. WS.0012964.2-13, Operational Noise Assessment for Proposed Guam Live-Fire Training Complex, 26 June 2013

1. We are enclosing a copy of the consultation.

2. Please contact us if we can be of any further assistance.

3. The point of contact is Ms. Kristy Broska, Environmental Protection Specialist or Ms. Catherine Stewart, Program Manager, Operational Noise, Army Institute of Public Health, at DSN 584-3829, Commercial (410) 436-3829, or email: kristy.a.broska.civ@mail.mil or catherine.m.stewart20.civ@mail.mil.

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OPERATIONAL NOISE CONSULTATION
No. WS.0012964.2-13
OPERATIONAL NOISE ASSESSMENT
PROPOSED GUAM LIVE-FIRE TRAINING RANGE COMPLEX
26 JUNE 2013

Preventive Medicine Surveys: 40-5f1

PHC FORM 433-E (MCHB-CS-IP), NOV 12

DEPARTMENT OF THE ARMY
US ARMY INSTITUTE OF PUBLIC HEALTH
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5403

MCHB-IP-EON

EXECUTIVE SUMMARY
OPERATIONAL NOISE CONSULTATION
No. WS.0012964.2-13
OPERATIONAL NOISE ASSESSMENT
PROPOSED GUAM LIVE-FIRE TRAINING RANGE COMPLEX
26 JUNE 2013

1. PURPOSE. To provide Naval Facilities Engineering Command, Pacific a noise assessment for an environmental analysis of optional locations for a proposed Hand Grenade Range at Andersen South and the proposed Live-Fire Training Range Complex (LFTRC). The proposed LFTRC locations are:

- Naval Munitions Site East-West
- Naval Munitions Site L-shaped
- Naval Munitions Site North-South
- Northwest Field
- Route 15A

2. CONCLUSIONS.

a. <u>LFTRC Small Caliber Range Activity.</u>

(1) <u>Naval Munitions Site East-West (NMS-EW) Alternative</u>. Although the Noise Zones for the NMS-EW alternative extend beyond the NMS and proposed land expansion area boundaries, the area surrounding the site is undeveloped and does not contain any noise-sensitive land uses. Within the existing NMS property, the Noise Zones do not encompass any noise-sensitive land uses.

(2) <u>Naval Munitions Site L-shaped (NMS-L) Alternative</u>. Although the Noise Zones for the NMS-L alternative extend beyond the boundary, the activity would be compatible with the surrounding land uses. Zone 1 extends beyond the northern boundary from the Multi-Purpose Machine Gun (MPMG) Range activity. Even though there are residential properties within the Zone 1 from MPMG Range activity, noise-sensitive land uses within Zone 1 are considered compatible. Within the off-base Zone 2, the land is undeveloped and does not contain any noise-sensitive land uses. Although the Noise Zones for the southern portion of NMS-L alternative extend beyond the boundary, the area surrounding the site is undeveloped and does not contain any noise-sensitive land uses. Within the existing NMS property, the Noise Zones do not encompass any noise-sensitive land uses.

(3) Naval Munitions Site North-South (NMS-NS) Alternative. Noise Zones 2 and 3 for the NMS-NS alternative are generally contained within the existing NMS property and the proposed expansion area; only approximately 30 acres extend beyond the boundary into undeveloped areas. Although there would be residences, north and east of NMS, exposed to Zone 1 levels from MPMG Range activity, noise levels would be compatible with existing land uses. Within the existing NMS property, the Noise Zones do not encompass any noise-sensitive land uses.

(4) Northwest Field (NWF) Alternative. Under the NWF option, the Noise Zones would be generally contained within the Andersen Air Force Base (AFB) boundary, the proposed NWF expansion area or the Department of Interior Wildlife Refuge Area. Along the northeastern coastline, Zone 1 and Zone 2 extend beyond the Andersen AFB boundary. Based on available imagery, within Zone 1 there are three residential structures. Lands within the remaining Noise Zones are undeveloped and do not contain any noise-sensitive land uses. Within Andersen AFB, Zone 1 extends to the Pacific Regional Training Center. Levels above 65 decibel (dB) A-weighted Day-Night Level (ADNL) (Zones 2 and 3) do not encompass any existing noise-sensitive land uses on Andersen AFB. However, there is a proposed Joint Threat Emitter (JTE) facility located approximately 250 meters from the proposed MPMG Range. The proposed JTE facility would be within Zone 2 (70-74 dB ADNL). If NWF is selected as the preferred alternative for the LFTRC, consideration for noise level reduction in the building design of the JTE facility may be necessary.

(5) Route 15A Alternative.

(a) The ranges in the northern area of the Route 15A land expansion area generate Noise Zones which extend beyond the land expansion area encompassing residential areas and undeveloped land. Noise-sensitive land uses are discouraged within 65-69 DNL and residential land use is strongly discouraged between 70-74 DNL. Based on available imagery, there are no noise-sensitive land uses within the Zone 3 that extends beyond the land expansion area. Zone 2 (65-69 dB ADNL) encompasses approximately 18 residential properties. Zone 2 (70-74 dB ADNL) encompasses four residential properties. Although Zone 1 encompasses multiple residential properties, noise-sensitive land uses are considered compatible within Zone 1.

(b) The ranges in the southern area of Route 15A land expansion area generate Zones 1 and 2 which extend beyond the southern boundary of Andersen South and the Route 15A land expansion area encompassing undeveloped land. Levels above 75 dB ADNL (Zone 3) do not extend beyond the boundary.

(c) The Noise Zones do not encompass any noise-sensitive land uses within Andersen South.

b. 40mm Grenade Launcher Activity. There would be a low risk of complaints from the 40mm Grenade activity at any of the proposed LFTRC sites.

c. Hand Grenade Range Activity. The Noise Zones remaining within Andersen South indicate that annual average noise levels from the proposed hand grenade activity are compatible with the surrounding environment. Yet, there is potential for individual events to cause annoyance and possibly generate noise complaints under unfavorable weather conditions.

3. RECOMMENDATIONS. Include the information from this consultation in the appropriate environmental analysis documentation.

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OPERATIONAL NOISE CONSULTATION
NO. WS.0012964.2-13
OPERATIONAL NOISE ASSESSMENT
PROPOSED GUAM LIVE-FIRE TRAINING RANGE COMPLEX
26 JUNE 2013

1. REFERENCES. A list of the references used in this consultation are in Appendix A. A glossary of terms and abbreviations used are in Appendix B.

2. AUTHORITY. The Naval Facilities Engineering Command, Pacific (NAVFAC PAC) funded this consultation to support proposed range development.

3. PURPOSE. To provide NAVFAC PAC a noise assessment for an environmental analysis of optional locations for a proposed Hand Grenade Range at Andersen South and the proposed Live-Fire Training Range Complex (LFTRC). The proposed LFTRC locations are:

- Naval Munitions Site East-West (NMS-EW)
- Naval Munitions Site L-shaped (NMS-L)
- Naval Munitions Site North-South (NMS-NS)
- Northwest Field (NWF)
- Route 15A

4. LAND USE GUIDELINES.

a. The noise exposure on communities is translated into Noise Zones. Often, there are existing “noise-sensitive” land uses that could be defined as non-conforming within the Noise Zones. Examples of noise-sensitive land uses are housing, schools, and medical facilities. In most cases, this is not a risk to community quality of life or mission sustainment. Long-term neighbors often acknowledge that they hear training, but most are not bothered by it. The intent is to offer land use recommendations, which if adopted both on and off the installation, would facilitate future development that is unaffected by military noise.

b. The 2008 U.S. Marine Corps (USMC) Order 3550.11 [Range Air Installations Compatible Use Zones Program (RAICUZ)] states that Day Night Levels (DNL) should be used to generate ordnance noise contours. However, the Order does not specifically address or exclude small arms activity. In instances where DNL is used to assess small arms, A-weighting is applied to account for the higher frequencies. Due to the ambiguity in the Order regarding how to address small arms noise, the NAVFAC PAC requested development of the A-weighted average sound Day Night Level (ADNL) noise contours for the small caliber weapon activity.

(1) The USMC noise guidance defines three Zones. In this consultation, they are used for the noise analysis of the proposed small caliber range activity:

- Noise-sensitive land uses are not compatible in *Zone 3 (> 75 DNL)*.
- Noise-sensitive land uses are generally not compatible in *Zone 2 (65-74* DNL. *Zone 2* is further defined as 65-69 DNL, where residential land use is discouraged and between 70-74 DNL, where residential land use is strongly discouraged.
- Noise-sensitive land uses are compatible in *Zone 1* (< 64 DNL). *Zone 1* is further defined as 55-64 DNL, where residential land use is compatible with restrictions. *Zone I* (< 55 DNL) residential land use is compatible with no restrictions. *Zone 1 (< 55 DNL)* is not one of the contours shown on the map; rather it is the entire area outside of the *Zone I* (55-64 DNL) contour.

(2) The USMC requested the following ADNL levels to be identified:

- Noise Zone 3: 75-79 ADNL; 80-84 ADNL; > 85 ADNL
- Noise Zone 2: 65-69 ADNL; 70-74 ADNL
- Noise Zone 1: < 55 ADNL; 55-64 ADNL

c. The RAICUZ states that for blast noise analysis, the Army's noise program criteria should be used. The Army program defines four Zones. In this consultation, they are used for the noise analysis of the proposed hand grenade activity:

- Noise-sensitive land uses are not recommended in *Zone III*.
- Although local conditions such as availability of developable land or cost may require noise-sensitive land uses in *Zone II*, this type of land use is strongly discouraged on the installation and in surrounding communities. All viable alternatives should be considered to limit development in *Zone II* to non-sensitive activities such as industry, manufacturing, transportation and agriculture.
- Noise-sensitive land uses are generally acceptable within the *Zone I*. However, though an area may only receive *Zone I* levels, military operations may be loud enough to be heard - or even judged loud on occasion. *Zone I* is not one of the contours shown on the map; rather it is the entire area outside of the *Zone II* contour.
- The *Land Use Planning Zone (LUPZ)* is a subdivision of *Zone I. The LUPZ* is 5 dB lower than the *Zone II*. Within this area, noise-sensitive land uses are generally acceptable. However, communities and individuals often have different views regarding what level of noise is acceptable or desirable. To address this, some local governments have implemented land use planning measures out beyond the *Zone II* limits. Additionally, implementing planning controls within the *LUPZ* can develop a buffer to avert the possibility of future noise conflicts.

5. NOISE CONTOURING PROCEDURES.

a. General. Gunshot sounds are impulsive in nature and occur over a very short period in time, only a few thousandths of a second. Unlike topographic contours, noise contours are not intended to be precise delineation of the noise zones. Meteorology, topography, density of intervening vegetation, the receiver's perception of the source, etc., can influence the level or impact of noise. Noise contours do not clearly divide noise zones with one side of the line compatible and the other side incompatible.

b. Small Caliber Activity.

(1) The standard U.S. Army noise simulation program used to assess small caliber weapons (.50 caliber and below) noise is the Small Arms Range Noise Assessment Model (SARNAM) (U.S. Army 2003). The SARNAM program requires operational data concerning types of weapons and range layout. The SARNAM calculation algorithms assume weather conditions or wind direction that favors sound propagation. The SARNAM program *cannot* account for the terrain at Guam.

(2) Table 1 lists the projected small caliber ammunition expenditure. The facilities will be utilized during daytime and evening hours (0600 – 2200). For the purpose of noise modeling, the hours between 0700 – 2200 are defined as “daytime” and between 2200 – 0700 hours as “nighttime”. Therefore, the total annual expenditure was distributed based on the number of operational hours (16 hours). This resulted in 1/16th of the activity being classified as "Nighttime 2200-0700" and the remaining as “Daytime 0700-2200”.

TABLE 1. PROJECTED SMALL CALIBER AMMUNITION EXPENDITURE

		Ammunition Expenditure Estimate		
Range	Weapon Ammunition	Daytime (0700-2200)	Nighttime (2200-0700)	Annual Total
Known Distance – Rifle	Rifle, 5.56mm	1,832,779	122,185	1,954,964
Known Distance -Pistol	Pistol, 9mm	322,935	21,529	344,464
Non Standard Small Arms	Rifle, 5.56mm	1,087,961	72,531	1,160,492
Modified Record Fire	Rifle, 5.56mm	416,906	27,794	444,700
Multi-purpose Machine Gun	Rifle, 5.56mm	353,535	23,569	377,104
	MG, 7.62mm	689,981	45,999	735,980
	MG, .50 cal	187,928	12,529	200,456

Note: cal = caliber, mm = millimeter, MG = Machine Gun

c. 40mm Grenade Launcher. The Multi Purpose Machine Gun (MPMG) Range activity includes firing the 40mm Training Practice (TP) rounds. The projected annual expenditure is 120,448 rounds during the daytime and evening hours (0600 – 2200). The launch noise of a 40mm grenade is addressed by looking at peak levels and estimating the complaint risk. There is no noise associated with the impact of the TP round. Launch noise levels associated with a moderate complaint risk would extend 300 meters (0.19 miles) to the side and 110 meters (361 feet) to the rear from the firing location. Appendix C contains details on the noise levels associated with the firing of the grenade launcher.

d. Hand Grenade Range Activity.

(1) The noise simulation program used to assess the demolition, explosive, and hand grenade noise is the Blast Noise Impact Assessment (BNOISE2) program (U.S. Army 2009). The BNOISE2 program requires operations data concerning the location of the range, the quantity and type of hand grenades utilized.

(2) To predict the risk of complaints for the hand grenade activity, peak contours were developed. The complaint risk contours are based on peak levels rather than a cumulative or average level; therefore, the size of the contours will not change if the number of detonations increases or decreases. The complaint risk noise levels to be identified for explosive activity are:

- Low Risk of Complaints – < 115 dB Peak
- Moderate Risk of Complaints – 115-130 dB Peak
- High Risk of Complaints – > 130 dB Peak

(3) Table 2 lists the ammunition expenditure utilized to develop the C-weighted average sound Day Night Level (CDNL) Noise Zones. The facilities will be utilized during daytime and evening hours (0800 – 1600). For the purpose of noise modeling, the hours between 0700 – 2200 are defined as “daytime” and between 2200 – 0700 hours as “nighttime”.

TABLE 2. PROJECTED HAND GRENADE EXPENDITURE

Facility	Weapon	Annual Expenditure	
		0700 – 2200 hours	2200-0700
Grenade Range	Hand Grenade, M67	421	0

6. NMS-EW ASSESSMENT.

a. Location. Figure 1 depicts the range locations for the NMS-EW Alternative.

b. Small Caliber Activity.

(1) Figure 2 contains the ADNL contours for the NMS-EW Alternative. Zone 1 (55-64 dB ADNL) extends less than 2,000 meters (1.24 miles) beyond the NMS-EW expansion area boundary, approximately 700 meters (0.44 mile) beyond the eastern NMS-EW expansion area boundary, and less than 1,700 meters (1.1 miles) beyond the southern NMS-EW expansion area boundary. Zone 2 (65-69 dB ADNL) and Zone 2 (70-74 dB ADNL) extend less than 700 meters (0.44 mile) and 250 meters (0.16 mile) beyond the northern and eastern NMS-EW expansion area boundaries. Zone 2 (65-69 dB ADNL) extends less than 250 meters (0.16 mile) beyond the southern NMS-EW expansion area boundary. Zone 3 (75-79 dB ADNL) and Zone 3 (80-84 dB ADNL) extend less than 125 meters (410 feet) and 50 meters (164 feet) beyond the eastern NMS-EW expansion area boundary. Zone 3 (>85 dB ADNL) does not extend beyond the boundary.

(2) The area surrounding the NMS-EW location is undeveloped and does not contain any noise-sensitive land uses.

(3) Within NMS, the Noise Zones do not encompass any noise-sensitive land uses.

(4) Table 3 indicates the total acreage and off-base acreage for each Noise Zone. For ease of discussion, the term “off-base” refers to areas outside of existing Department of Defense (DoD) property and/or the proposed land acquisition area. Appendix D depicts the acreages of the Noise Zones outside of existing DoD property and/or the proposed land acquisition area.

TABLE 3. NMS-EW NOISE ZONE ACREAGES

Noise Zone	**Total Acreage**	**Off-Base Acreage**	**Off-Base Land Use**
Zone 1 (55-64 dB ADNL)	3395.1	1897.4	Undeveloped
Zone 2 (65-69 dB ADNL)	675.0	175.3	Undeveloped
Zone 2 (70-74 dB ADNL)	343.2	52.0	Undeveloped
Zone 3 (75-79 dB ADNL)	175.8	12.0	Undeveloped
Zone 3 (80-84 dB ADNL)	122.4	0.8	Undeveloped
Zone 3 (> 85 dB ADNL)	191.2	0.0	n/a
TOTAL	4902.8	2137.5	

c. <u>40mm Grenade Launcher</u>. As previously mentioned, the MPMG Range activity includes firing the 40mm TP rounds. Noise levels associated with a moderate complaint risk would extend 300 meters from the firing location; beyond 300 meters the risk of complaints would be low. Although the proposed MPMG Range is only approximately 175 meters (0.1 mile) from the boundary of the proposed expansion area, there would be a low risk of complaints from grenade launcher activity as the surrounding area is undeveloped.

d. <u>Findings.</u> Although the Noise Zones for the small caliber ranges for the NMS-EW alternative extend beyond the expansion area boundary, the area surrounding the site is undeveloped and does not contain any noise-sensitive land uses. There is a low risk of complaints from the 40mm grenade launcher activity.

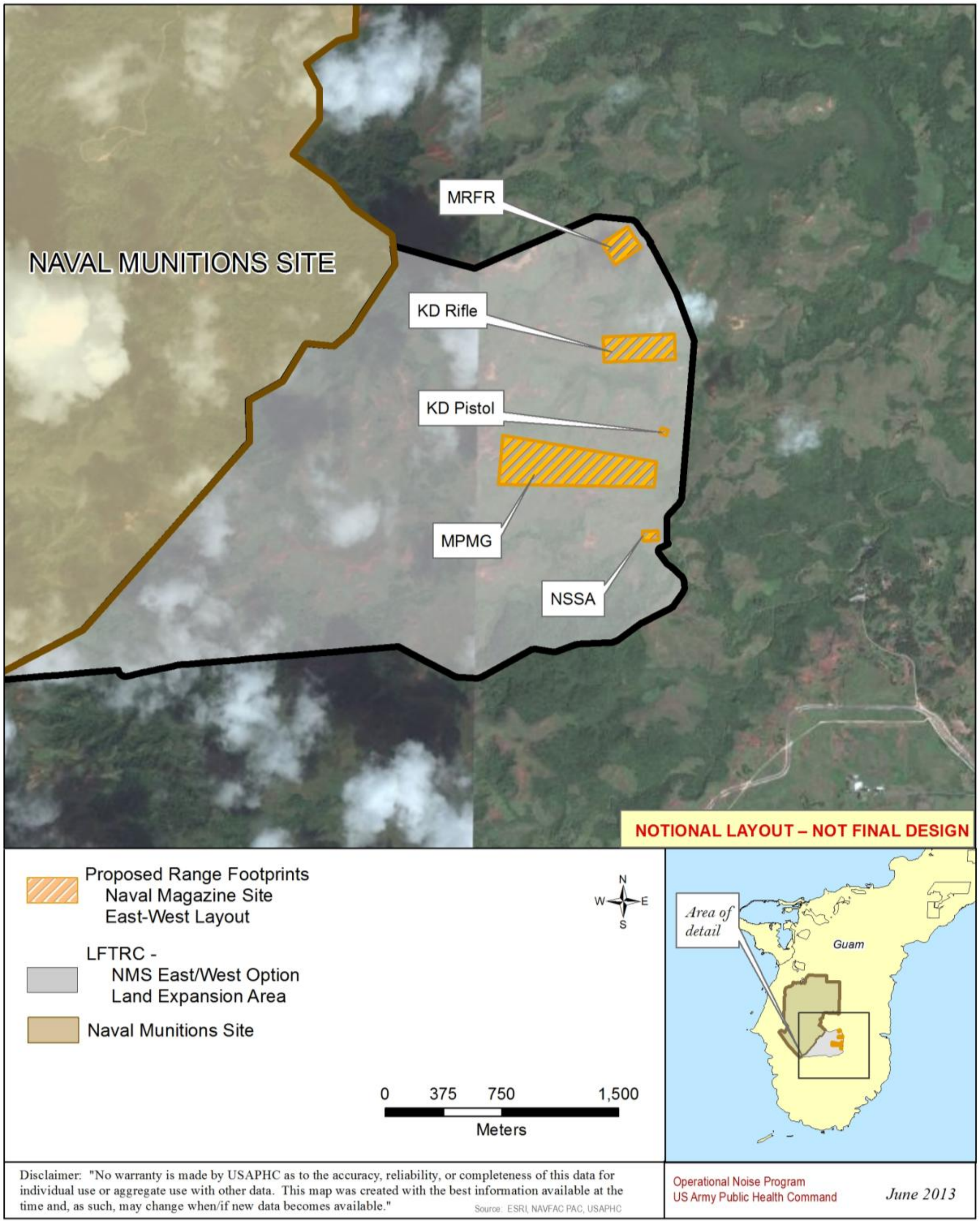


FIGURE 1. NMS-EW ALTERNATIVE LAYOUT

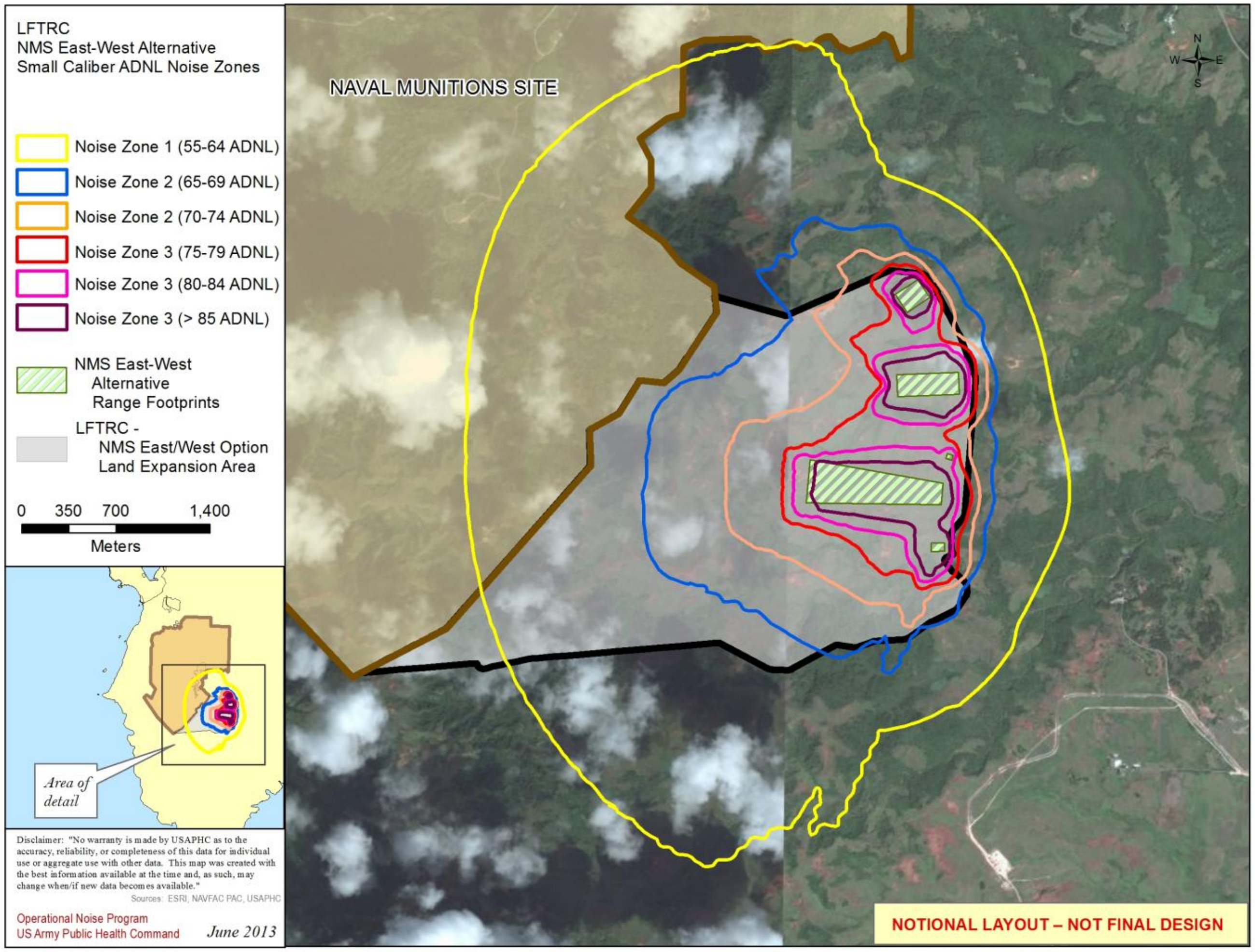


FIGURE 2. NMS-EW ALTERNATIVE SMALL CALIBER NOISE ZONES

8

7. NMS-L ASSESSMENT.

a. Location. Figure 3 depicts the range locations for the NMS-L Alternative.

b. Small Caliber Activity. Figure 4 contains the ADNL contours for the NMS-L Alternative.

(1) In the northern area of NMS, the MPMG generates a Zone 1 (55-64 dB ADNL) which extends less than 450 meters (0.28 mile) beyond the northern expansion area boundary and approximately 1,500 meters (0.93 mile) beyond the western expansion area boundary. Zone 2 (65-69 dB ADNL) and Zone 2 (70-74 dB ADNL) extend less than 160 meters (525 feet) and less than 40 meters (130 feet) beyond the western NMS-L expansion area boundary respectively. Zone 3 (> 75 dB ADNL) remains within NMS and the NMS-L expansion area.

(2) Within the off-base Zone 1, the area is primarily undeveloped with two small areas of residential development. To the north along Route 12, there are approximately 50 structures within the off-base Zone 1. Based on available imagery, the structures within the area appear to be a mix of non-residential and residential construction. To the west in the South Pahong Street area there are approximately 100 structures within the off-base Zone 1. Based on available imagery, the structures within the area appear to be residential construction. Within the off-base Zone 2, the land is undeveloped and does not contain any noise-sensitive land uses.

(3) The ranges in the southern area of NMS generate a Zone 1 (55-64 dB ADNL) which extends up to 1,600 meters (0.99 mile) beyond the NMS-L expansion area boundary. Zone 2 (65-69 dB ADNL) and Zone 2 (70-74 dB ADNL) extend less than 550 meters (0.34 mile) and 150 meters (492 feet) beyond the NMS-L expansion area boundary respectively. Zone 3 (75-79 dB ADNL) and Zone 3 (80-84 dB ADNL) extend less than 200 meters (0.12 mile) and 100 meters (328 feet) beyond the NMS-L expansion area boundary. Zone 3 (>85 dB ADNL) extends less than 27 meters (89 feet) beyond the NMS-L expansion area boundary. The area surrounding the southern area of NMS-L location is undeveloped and does not contain any noise-sensitive land uses.

(4) Within the existing NMS property, the Noise Zones do not encompass any noise-sensitive land uses.

(5) Table 4 indicates the total acreage and off-base acreage for each Noise Zone.

TABLE 4. NMS-L NOISE ZONE ACREAGES

		Northern Area		Eastern Area	
Noise Zone	**Total Acreage**	**Off-Base Acreage**	**Off-Base Land Use**	**Off-Base Acreage**	**Off-Base Land Use**
Zone 1 (55-64 dB ADNL)	4320.7	774.1	Mostly undeveloped. 2 residential areas	1254.1	Undeveloped
Zone 2 (65-69 dB ADNL)	851.0	21.6	Undeveloped	199.1	Undeveloped
Zone 2 (70-74 dB ADNL)	457.2	0.6	Undeveloped	74.7	Undeveloped
Zone 3 (75-79 dB ADNL)	187.6	0.0	n/a	26.1	Undeveloped
Zone 3 (80-84 dB ADNL)	115.8	0.0	n/a	5.9	Undeveloped
Zone 3 (> 85 dB ADNL)	192.3	0.0	n/a	1.1	Undeveloped
TOTAL	**6124.5**	**796.3**		**1561.2**	

c. 40mm Grenade Launcher. As previously mentioned, the MPMG Range activity includes firing the 40mm TP rounds. Noise levels associated with a moderate complaint risk would extend 300 meters (0.19 mile) from the firing location; beyond 300 meters the risk of complaints would be low. There would be a low risk of complaints from grenade launcher activity, since the closest boundary to the proposed MPMG Range is the existing NMS property line, approximately 350 meters (0.22 miles) to the rear of the proposed location.

d. Findings. Zone 1 extends beyond the northern boundary from the MPMG Range activity. Even though there are residential properties within the Zone 1 from MPMG Range activity, noise-sensitive land uses within Zone 1 are considered compatible. Although the Noise Zones for the southern portion of NMS-L alternative extend beyond the expansion area boundary. the area surrounding the site is undeveloped and does not contain any noise-sensitive land uses. There is a low risk of complaints from the 40mm grenade launcher activity.

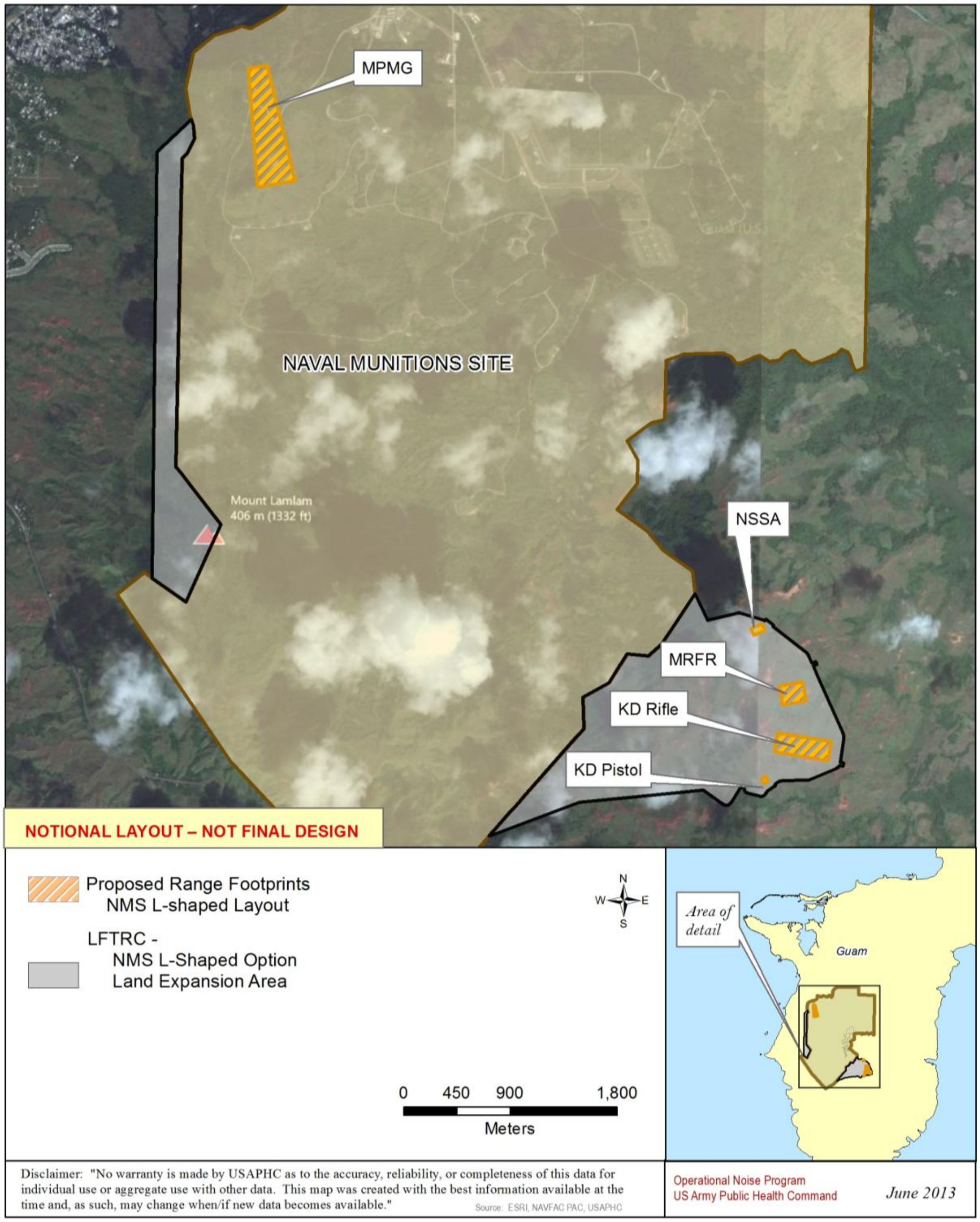


FIGURE 3. NMS-L ALTERNATIVE LAYOUT

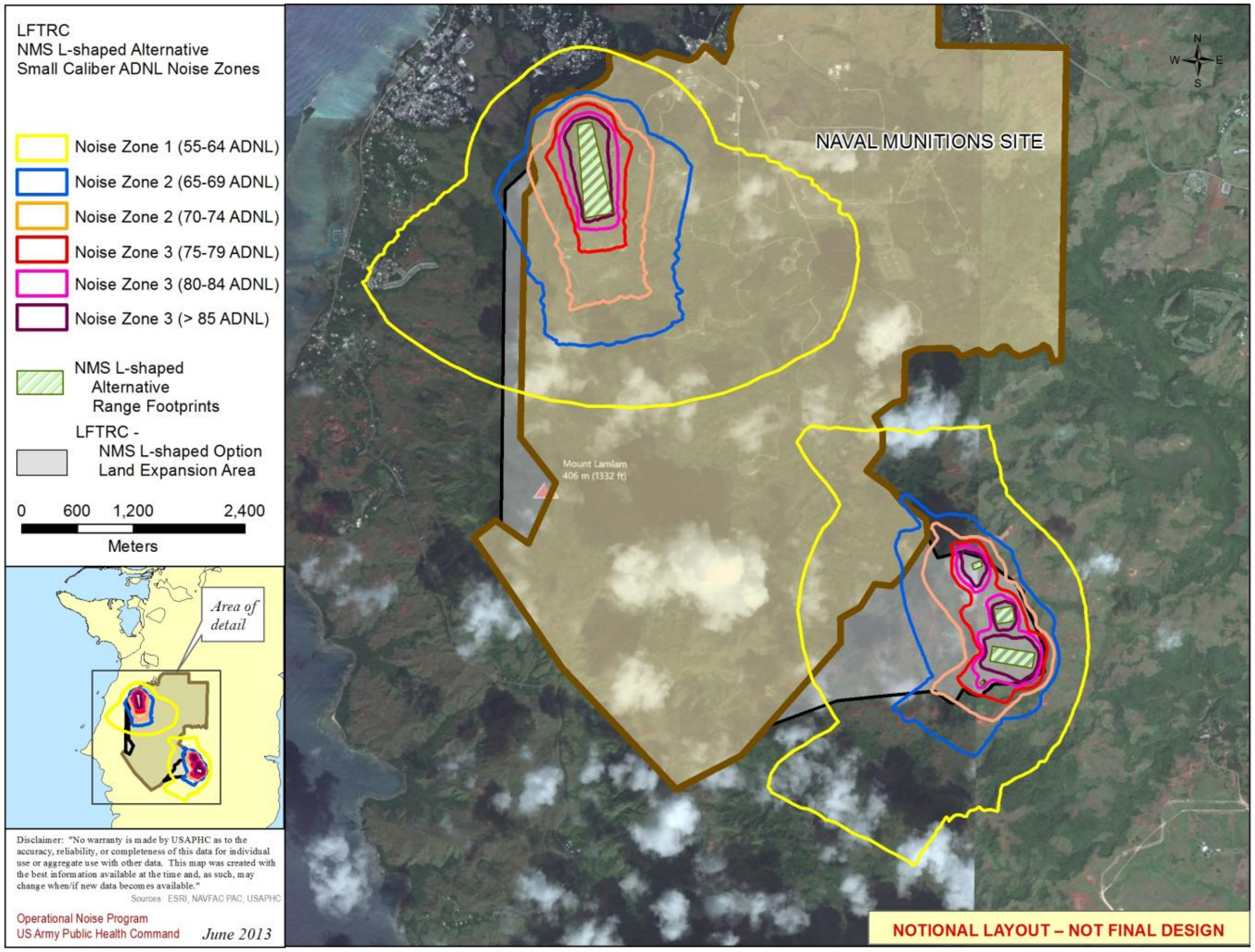


FIGURE 4. NMS-L ALTERNATIVE SMALL CALIBER NOISE ZONES

8. NMS-NS ASSESSMENT.

a. Location. Figure 5 depicts the range locations for the NMS-NS Alternative.

b. Small Caliber Activity. Figure 6 contains the ADNL contours for the NMS-NS Alternative.

(1) Zone 1 (55-64 dB ADNL) which extends less than 500 meters (0.31 mile) beyond the northern NMS boundary and approximately 1,700 meters (1.06 miles) beyond the western expansion area boundary. Zone 2 (65-69 dB ADNL) and Zone 2 (70-74 dB ADNL) extends less than 160 meters (525 feet) and less than 40 meters (130 feet) beyond the western NMS expansion area boundary respectively.
Zone 3 (> 75 dB ADNL) remains within NMS and the NMS expansion area.

(2) Within the off-base Zone 1, the area is primarily undeveloped with two small areas of residential development. To the north along Route 12 there are approximately 60 structures within the off-base Zone 1. Based on available imagery, the structures within the area appear to a mix of non-residential and residential construction. To the west in the South Pahong Street area there are approximately 110 structures within the off-base Zone 1. Based on available imagery, the structures within the area appear to be primarily of residential construction. Within the off-base Zone 2, the land is undeveloped and does not contain any noise-sensitive land uses.

(3) Within the existing NMS property, the Noise Zones do not encompass any noise-sensitive land uses.

(4) Table 5 indicates the total acreage and off-base acreage for each Noise Zone.

TABLE 5. NMS-NS NOISE ZONE ACREAGES

Noise Zone	Total Acreage	Off-Base Acreage	Off-Base Land Use
Zone 1 (55-64 dB ADNL)	2,627.9	993.3	Mostly undeveloped. 2 residential areas
Zone 2 (65-69 dB ADNL)	722.9	29.9	Undeveloped
Zone 2 (70-74 dB ADNL)	501.0	0.7	Undeveloped
Zone 3 (75-79 dB ADNL)	219.9	0.0	n/a
Zone 3 (80-84 dB ADNL)	105.3	0.0	n/a
Zone 3 (> 85 dB ADNL)	185.8	0.0	n/a
TOTAL	**4,362.7**	**1,023.9**	

c. 40mm Grenade Launcher. Noise levels associated with a moderate complaint risk would extend 300 meters (0.19 mile) from the firing location; beyond 300 meters the risk of complaints would be low. There would be a low risk of complaints from grenade launcher activity, since the closest boundary to the proposed MPMG Range is the existing NMS property line, approximately 350 meters (0.22 miles) to the rear of the proposed location.

d. Findings. The Noise Zones for the small caliber ranges for the NMS-NS alternative are generally contained within NMS. Although the MPMG Range generates a Zone 1 which encompasses some residential properties, noise-sensitive land uses within Zone 1 is considered compatible. There is a low risk of complaints from the 40mm grenade launcher activity.

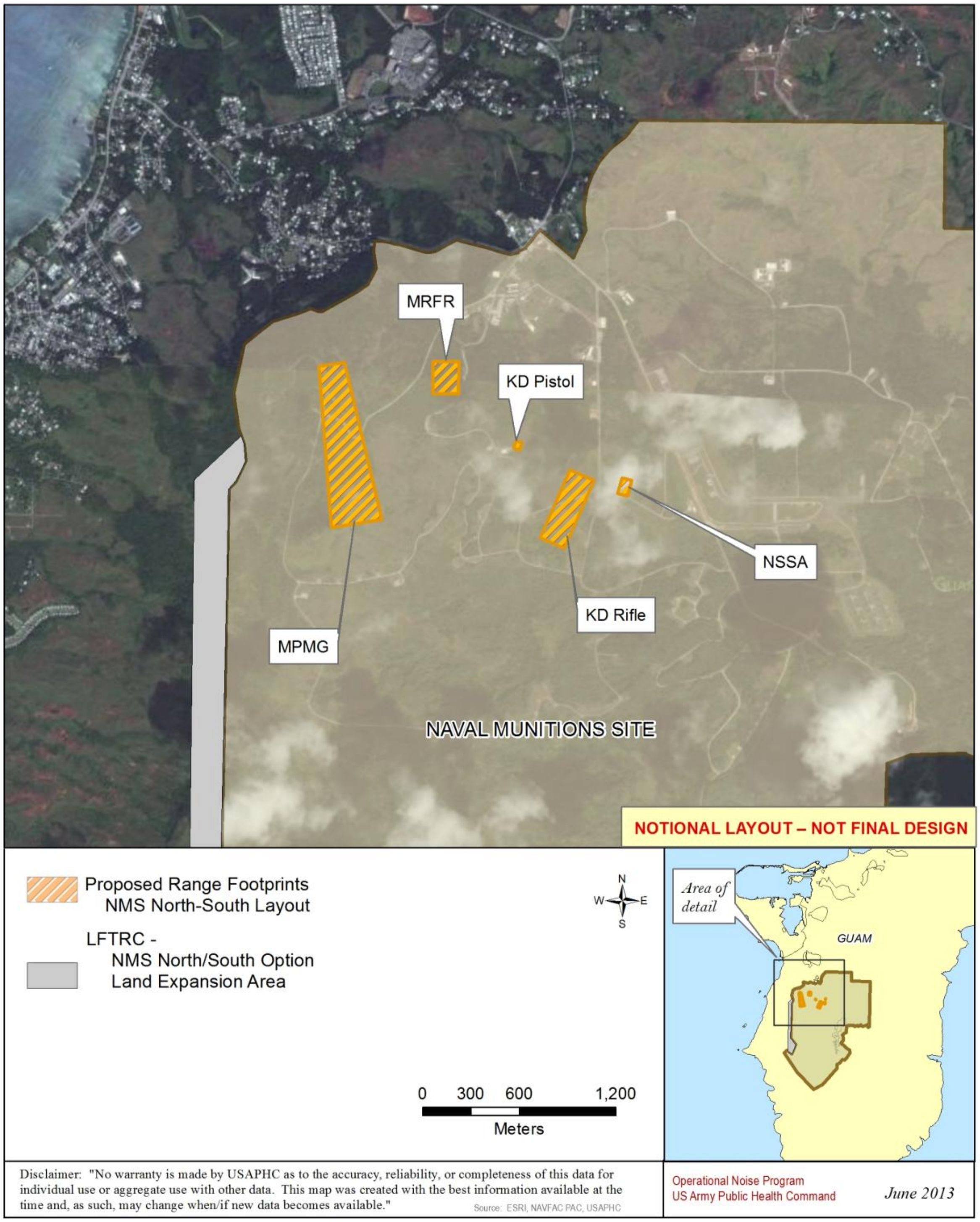


FIGURE 5. NMS-NS ALTERNATIVE LAYOUT

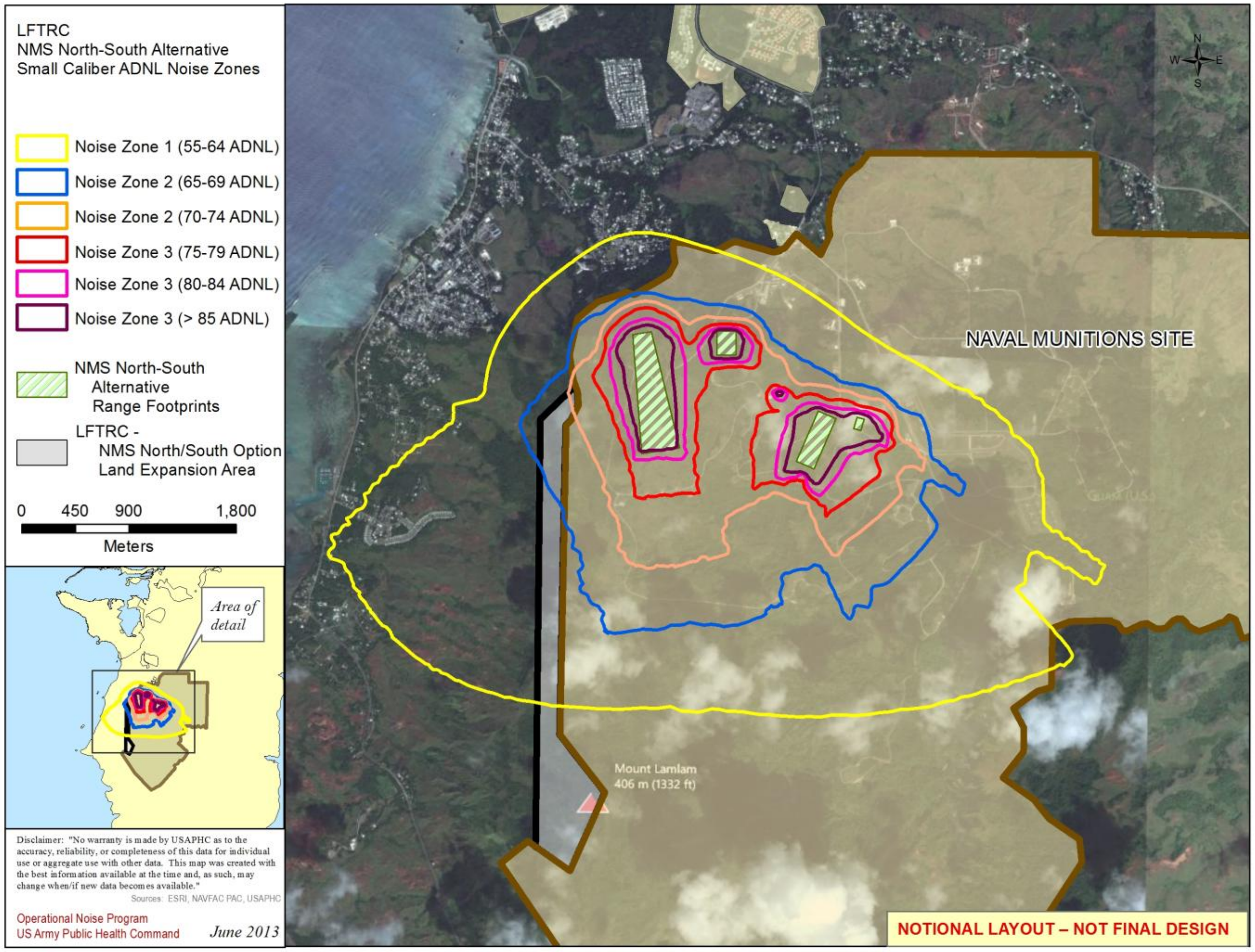


FIGURE 6. NMS-NS ALTERNATIVE SMALL CALIBER NOISE ZONES

9. NWF ASSESSMENT.

a. Location. Figure 7 depicts the range locations for the NWF Alternative.

b. Small Caliber Activity. Figure 8 contains the ADNL contours for the NWF Alternative.

(1) Along the northeastern coastline, the Noise Zones encompass the majority of the non-military land between the Andersen Air Force Base (AFB) boundary and the NWF expansion area. Along the northeastern coastline, there are three residential structures within Zone 1 (55-64 dB ADNL). Zone 1 also extends approximately 100 meters (328 feet) beyond the western edge of Andersen AFB encompassing the Department of Interior (DoI) Wildlife Refuge Area. Zone 2 (65-69 dB ADNL) extends approximately 300 meters (0.19 mile) and Zone 2 (70-74 dB ADNL) extends less than 120 meters (394 feet) beyond the northeastern Andersen AFB boundary. Based on available imagery there are no structures within Zone 2 area. Levels above 75 dB ADNL (Zone 3) remain with Andersen AFB.

(2) Within the existing Andersen AFB property, Zone 1 (55-64 dB ADNL) extends to the Pacific Regional Training Center. Levels above 65 dB ADNL (Zones 2 and 3) do not encompass any existing noise-sensitive land uses on Andersen AFB. However, there is a proposed Joint Threat Emitter (JTE) facility located approximately 250 meters from the proposed MPMG Range. The proposed JTE facility would be within the Zone 2 (70-74 dB ADNL). If NWF is selected as the preferred alternative for the LFTRC, consideration for noise level reduction in the building design of the JTE facility may be necessary.

(3) Table 6 indicates the total acreage and off-base acreage for each Noise Zone.

TABLE 6. NWF NOISE ZONE ACREAGES

Noise Zone	Total Acreage	Land		Ocean Acreage
		Off-Base Acreage	Off-Base Land Use	
Zone 1 (55-64 dB ADNL)	3,642.2	110.6	Primarily undeveloped with three residential structures, DoI Wildlife Refuge	3,068.9
Zone 2 (65-69 dB ADNL)	665.9	45.4	Undeveloped, DoI Wildlife Refuge	314.9
Zone 2 (70-74 dB ADNL)	363.0	2.8	Undeveloped	73.6
Zone 3 (75-79 dB ADNL)	223.4	0.0	n/a	0.0
Zone 3 (80-84 dB ADNL)	122.7	0.0	n/a	0.0
Zone 3 (> 85 dB ADNL)	185.6	0.0	n/a	0.0
TOTAL	**5,202.7**	**158.8**		**3,457.4**

c. <u>40mm Grenade Launcher</u>. Noise levels associated with a moderate complaint risk would extend 300 meters (0.19 mile) from the firing location; beyond 300 meters the risk of complaints would be low. Since the proposed MPMG Range is approximately 950 meters (0.6 mile) from the closest boundary, there would be a low risk of complaints from grenade launcher activity.

d. <u>Findings.</u> Under the NWF option, the small caliber Noise Zone would be generally contained within the Andersen AFB boundary, within the proposed NWF expansion area or within the DoI land. Along the northeastern coastline, the Noise Zones encompass the majority of the non-military land between the Andersen AFB boundary and the NWF expansion area. Based on available imagery, the Zone 2 areas are undeveloped and do not contain any noise-sensitive land uses. There is a low risk of complaints from the 40mm grenade launcher activity.

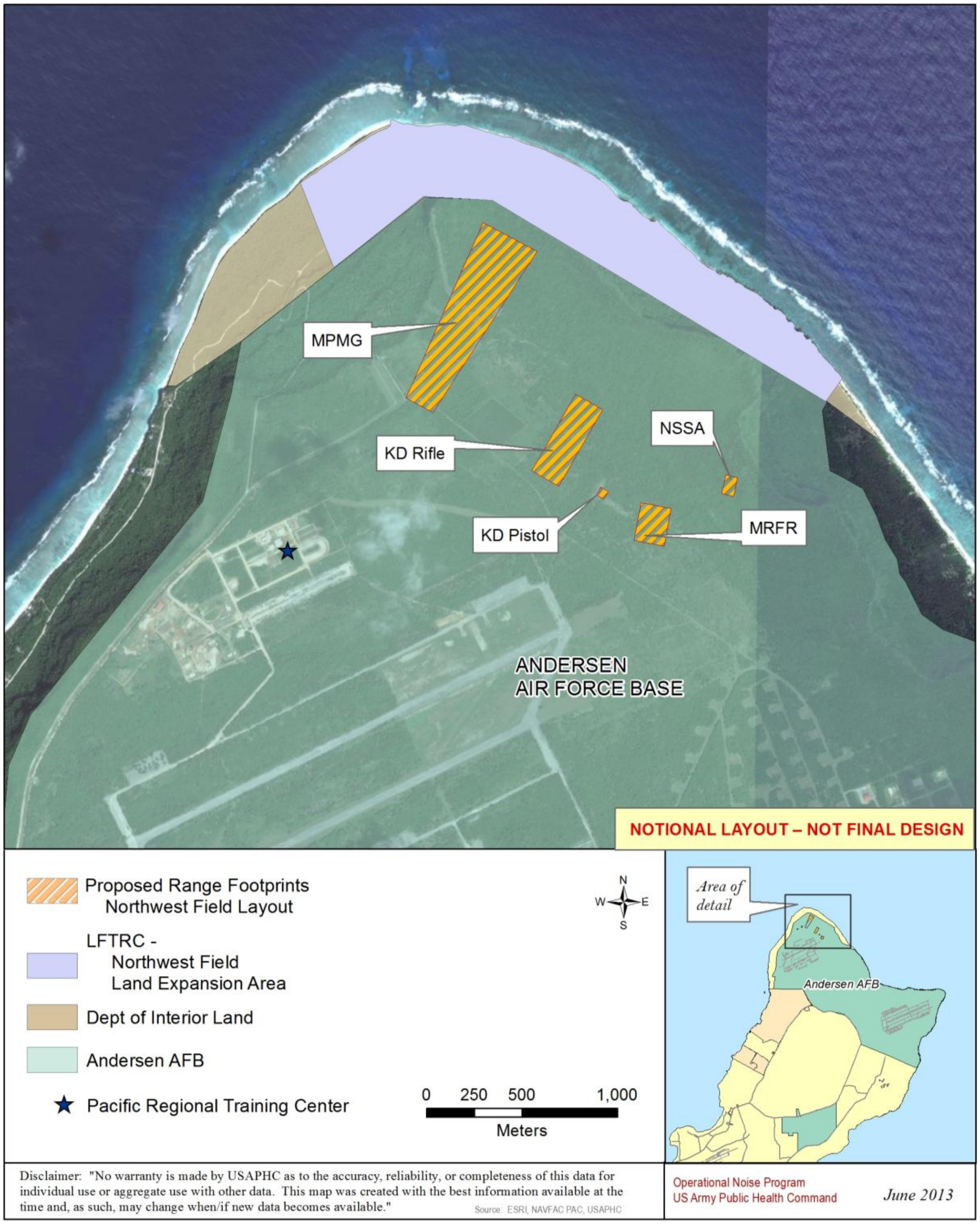


FIGURE 7. NWF ALTERNATIVE LAYOUT

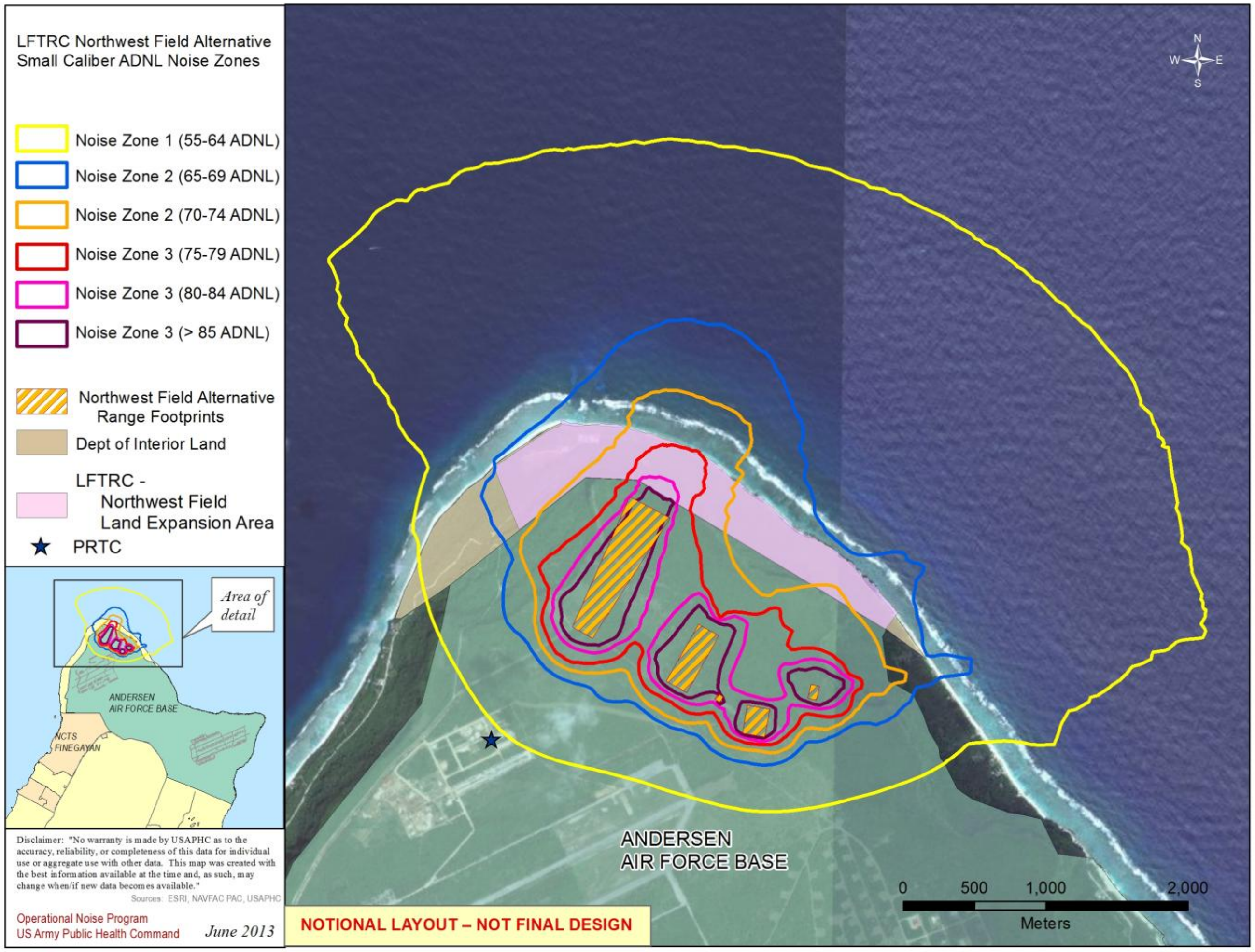


FIGURE 8. NWF ALTERNATIVE SMALL CALIBER NOISE ZONES

10. ROUTE 15A ASSESSMENT.

a. Location. Figure 9 depicts the range locations for the Route 15A Alternative.

b. Small Caliber Activity. Figure 10 contains the ADNL contours for the Route 15A Alternative.

(1) The ranges in the northern area of the Route 15A land expansion area generate Noise Zones which extend beyond the land expansion area encompassing residential areas and undeveloped land. Zone 1 (55-64 dB ADNL) extends up to 1,300 meters (0.81 mile) beyond the northern boundary of the Route 15A land expansion area. Zone 2 (65-69 dB ADNL) extends approximately 300 meters (0.19 mile) and Zone 2 (70-74 dB ADNL) extends less than 130 meters (0.08 mile) beyond the northern boundary of the land expansion area. Zone 3 (75-79 dB ADNL) extends less than 70 meters (230 feet) beyond the land expansion area. Levels above 80 dB ADNL (Zone 3) remain within the Route 15A land expansion area. Within the Zone 3 that extends beyond the land expansion area there are no noise-sensitive land uses.

(2) Within the Noise Zones beyond the land expansion area, the areas are primarily undeveloped with a small area of residential development. To the north along Route 15 there are approximately 80 structures within the Zone 1; 18 structures within Zone 2 (65-69 dB ADNL) and four structures within the Zone 2 (70-74 dB ADNL). Based on available imagery, the structures within these areas appear to be primarily of residential construction.

(3) The ranges in the southern area of Route 15A land expansion area generate Noise Zones which extend beyond the land expansion area encompassing undeveloped land. Zone 1 (55-64 dB ADNL) extends approximately 1,000 meters (0.62 mile) beyond the southwestern boundaries. Zone 2 (65-69 dB ADNL) extends approximately 500 meters (0.31 mile) and Zone 2 (70-74 dB ADNL) extends less than 200 meters (0.12 mile) beyond the southern boundary of Andersen South and the Route 15 A land expansion area. Levels above 75 dB ADNL (Zone 3) do not extend beyond the Andersen South and the Route 15 A land expansion area boundaries.

(4) The Noise Zones do not encompass any noise-sensitive land uses within the existing Andersen South property.

(5) Table 7 indicates the total acreage and off-base acreage for each Noise Zone.

TABLE 7. ROUTE 15A NOISE ZONE ACREAGES

Noise Zone	Total Acreage	Land		Ocean Acreage
		Off-Base Acreage	Off-Base Land Use	
Zone 1 (55-64 dB ADNL)	2,906.8	638.2	Mostly undeveloped; 3 residential areas	1,838.2
Zone 2 (65-69 dB ADNL)	834.3	97.7	Mostly undeveloped with scattered residential	482.0
Zone 2 (70-74 dB ADNL)	475.7	31.9	Mostly undeveloped with scattered residential	95.4
Zone 3 (75-79 dB ADNL)	182.8	3.4	Undeveloped	0
Zone 3 (80-84 dB ADNL)	97.7	0	n/a	0
Zone 3 (> 85 dB ADNL)	178.5	0	n/a	0
TOTAL	**4,675.8**	**771.2**		**2,415.6**

c. <u>40mm Grenade Launcher</u>. Since the proposed MPMG Range is approximately 650 meters (0.4 mile) from the boundary of the proposed expansion area, noise levels beyond the boundary would be too low to pose a complaint risk.

d. <u>Findings.</u> Noise-sensitive land uses are discouraged within 65-69 DNL and between 70-74 DNL residential land use is strongly discouraged. Based on available imagery, Zone 2 (65-69 dB ADNL) encompasses approximately 18 residential properties. Zone 2 (70-74 dB ADNL) encompasses four residential properties. Although Zone 1 (55-64 dB ADNL) encompasses multiple residential properties noise-sensitive land uses within Zone 1 is considered compatible. There is a low risk of complaints from the 40mm grenade launcher activity.

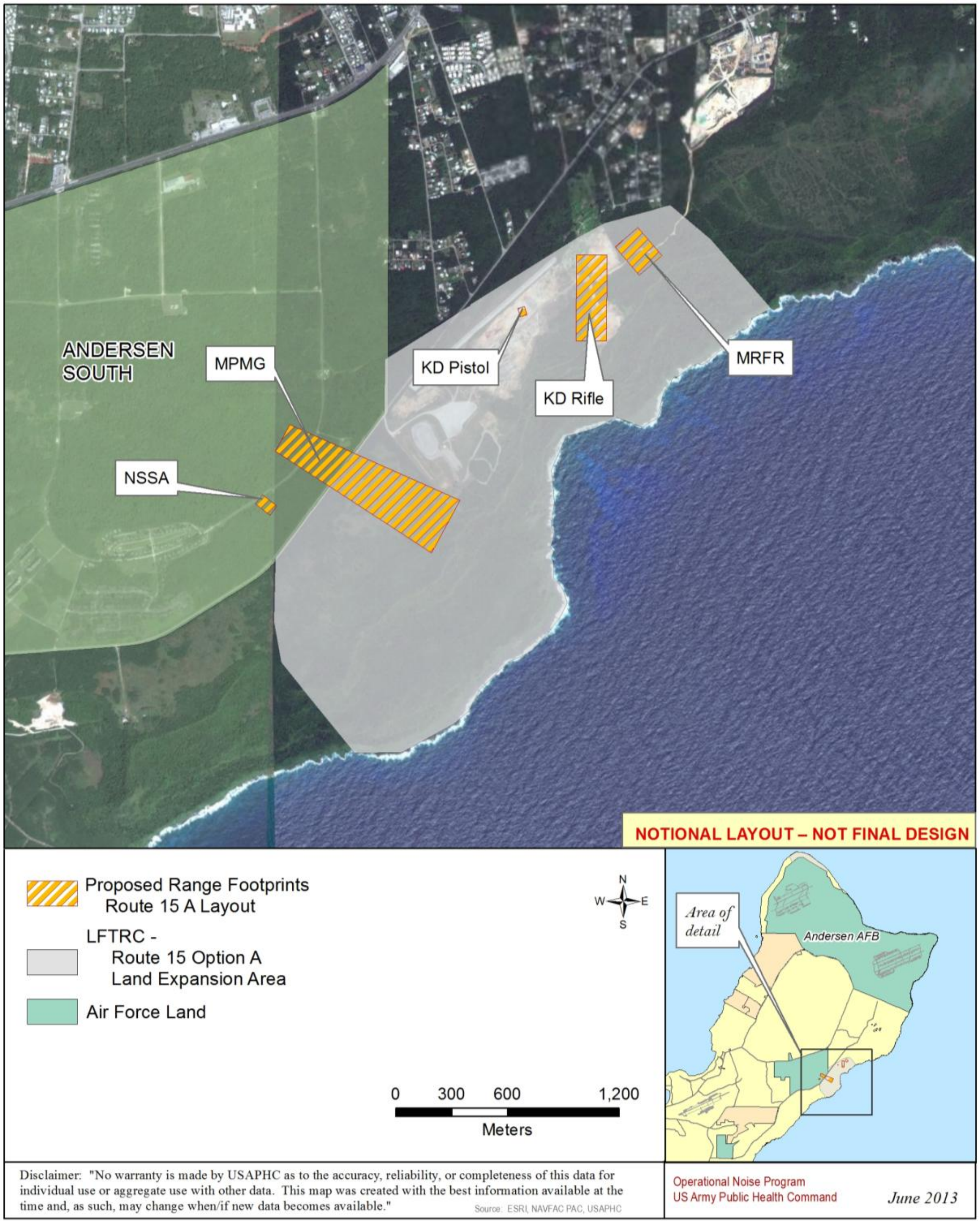


FIGURE 9. ROUTE 15A ALTERNATIVE LAYOUT

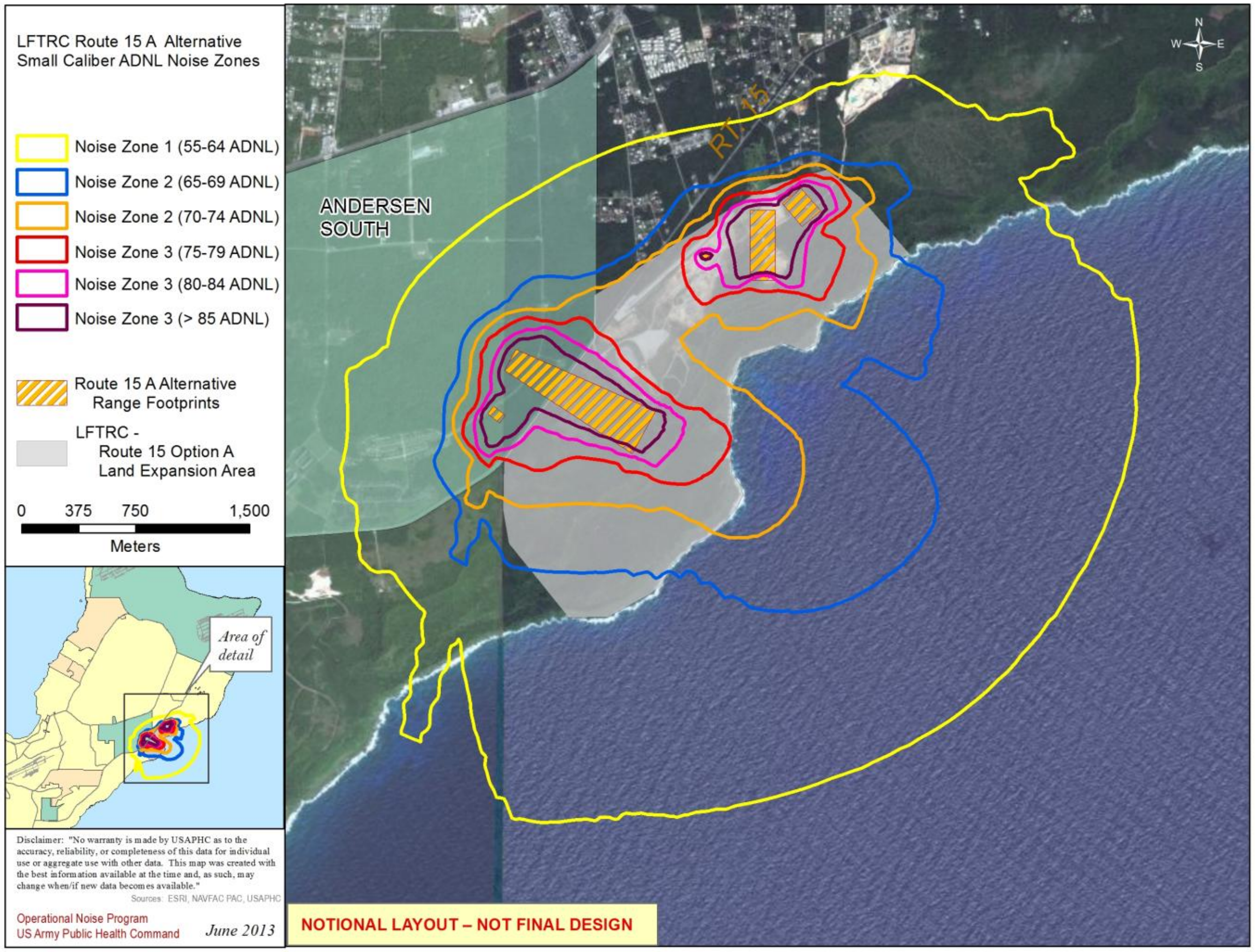


FIGURE 10. ROUTE 15A ALTERNATIVE SMALL CALIBER NOISE ZONES

11. HAND GRENADE RANGE ASSESSMENT.

a. Location. Figure 11 depicts the proposed hand grenade range location at Andersen South.

b. Land Use Compatibility Noise Zones. Figure 12 contains the annual average Noise Zones for the Hand Grenade Range.

(1) The Noise Zones do not extend beyond the boundary of Andersen South. Within Andersen South, the Noise Zones do not encompass any noise-sensitive land uses.

(2) Table 8 indicates the total acreage for each Noise Zone.

TABLE 8. HAND GRENADE RANGE NOISE ZONE ACREAGES

Noise Zone	Total Acreage	Off-Base Acreage
LUPZ (57-62 dB CDNL)	213.2	0
Zone II (62-70 dB CDNL)	128.4	0
Zone III (> 70 dB CDNL)	26.4	0
TOTAL	**368.0**	**0**

c. Complaint Risk Areas. Figure 13 contains the complaint risk areas for the Hand Grenade Range under unfavorable weather conditions. The moderate risk of complaint area extends beyond the boundary up to 1,200 meters (0.75 mile). The high risk of complaint area does not extend beyond the boundary. Within the off-base moderate complaint risk areas, there are multiple residential areas. It should be noted that if activities take place under neutral or favorable weather conditions, such as the wind blowing away from the receiver, noise levels would be lower (Figure 14).

d. Findings. The Noise Zones remaining on base indicate that annual average noise levels from the proposed hand grenade activity are compatible with the surrounding environment. Yet, there is potential for individual events to cause annoyance and possibly generate noise complaints under unfavorable weather conditions.

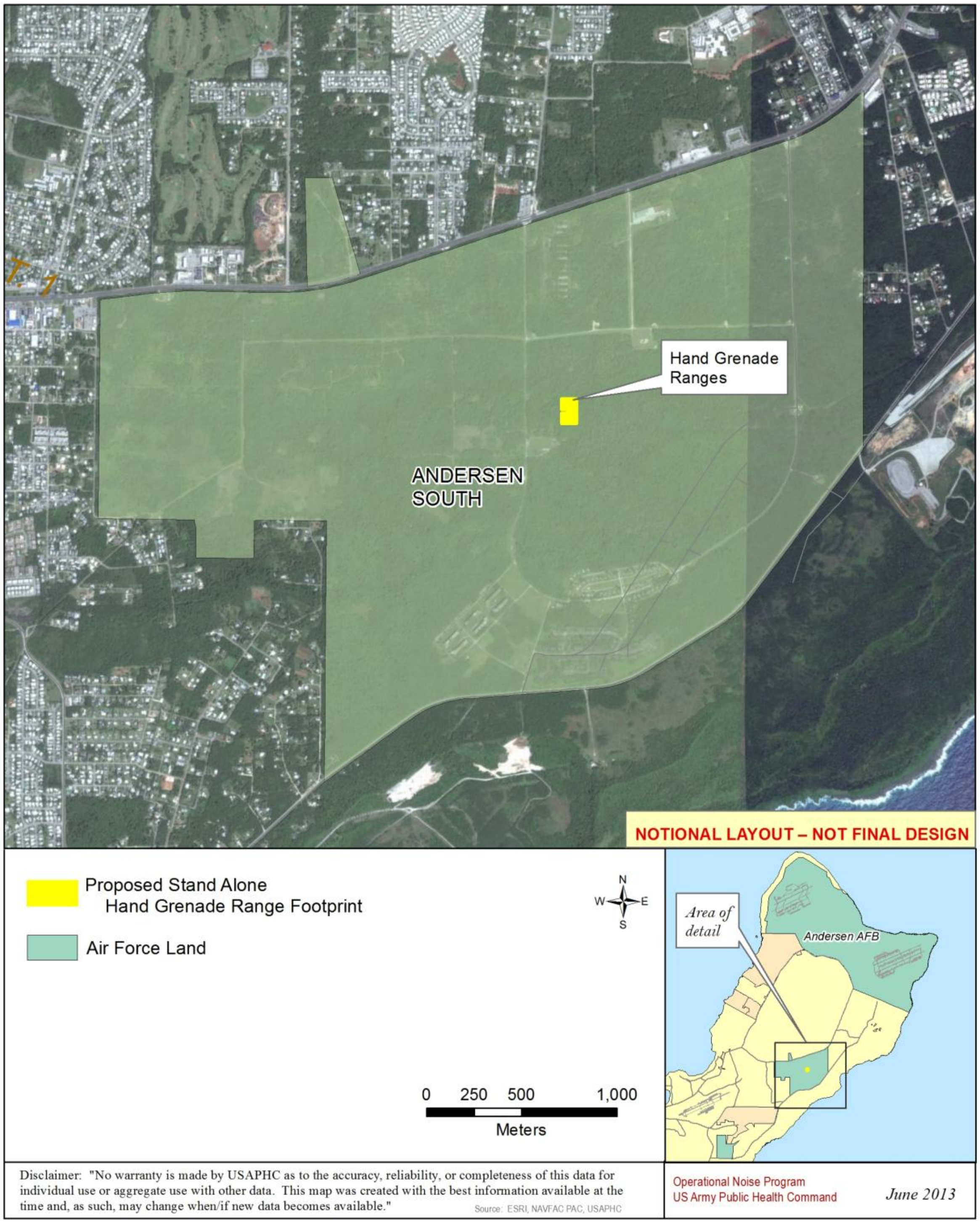


FIGURE 11. PROPOSED HAND GRENADE RANGE LOCATION

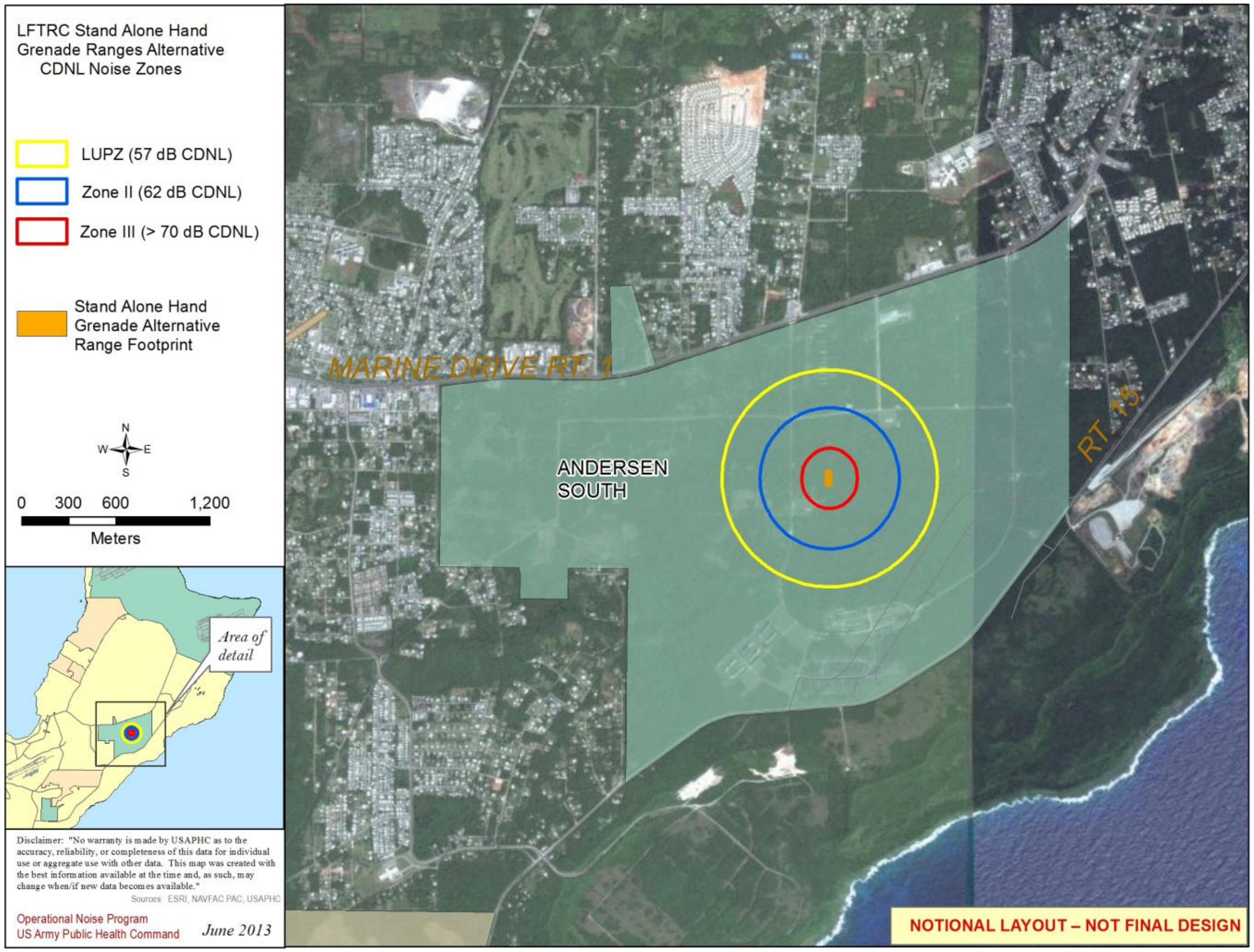
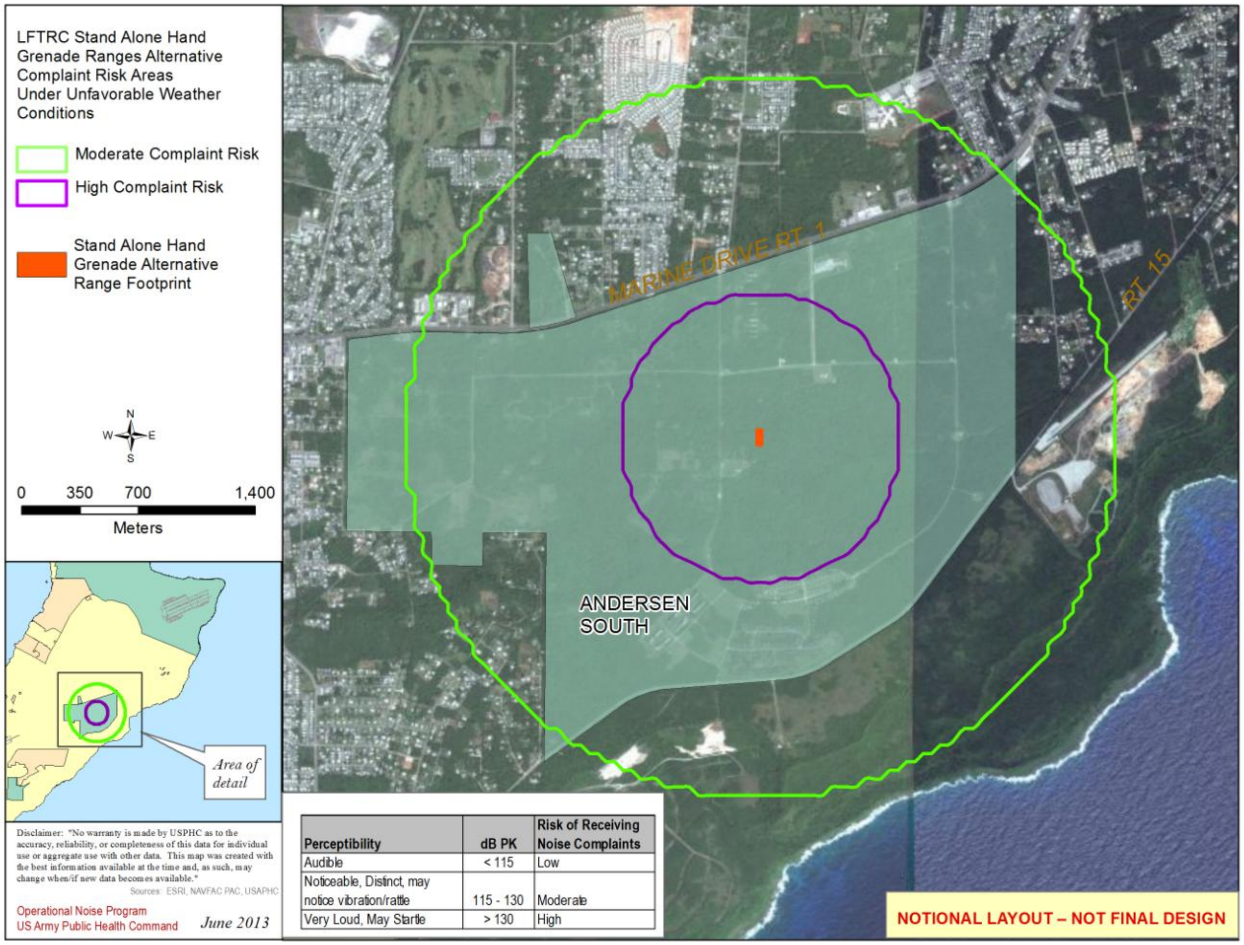


FIGURE 12. PROJECTED HAND GRENADE RANGE NOISE ZONES



Perceptibility	dB PK	Risk of Receiving Noise Complaints
Audible	< 115	Low
Noticeable, Distinct, may notice vibration/rattle	115 - 130	Moderate
Very Loud, May Startle	> 130	High

FIGURE 13. PROJECTED HAND GRENADE COMPLAINT RISK AREAS UNDER UNFAVORABLE WEATHER CONDITIONS

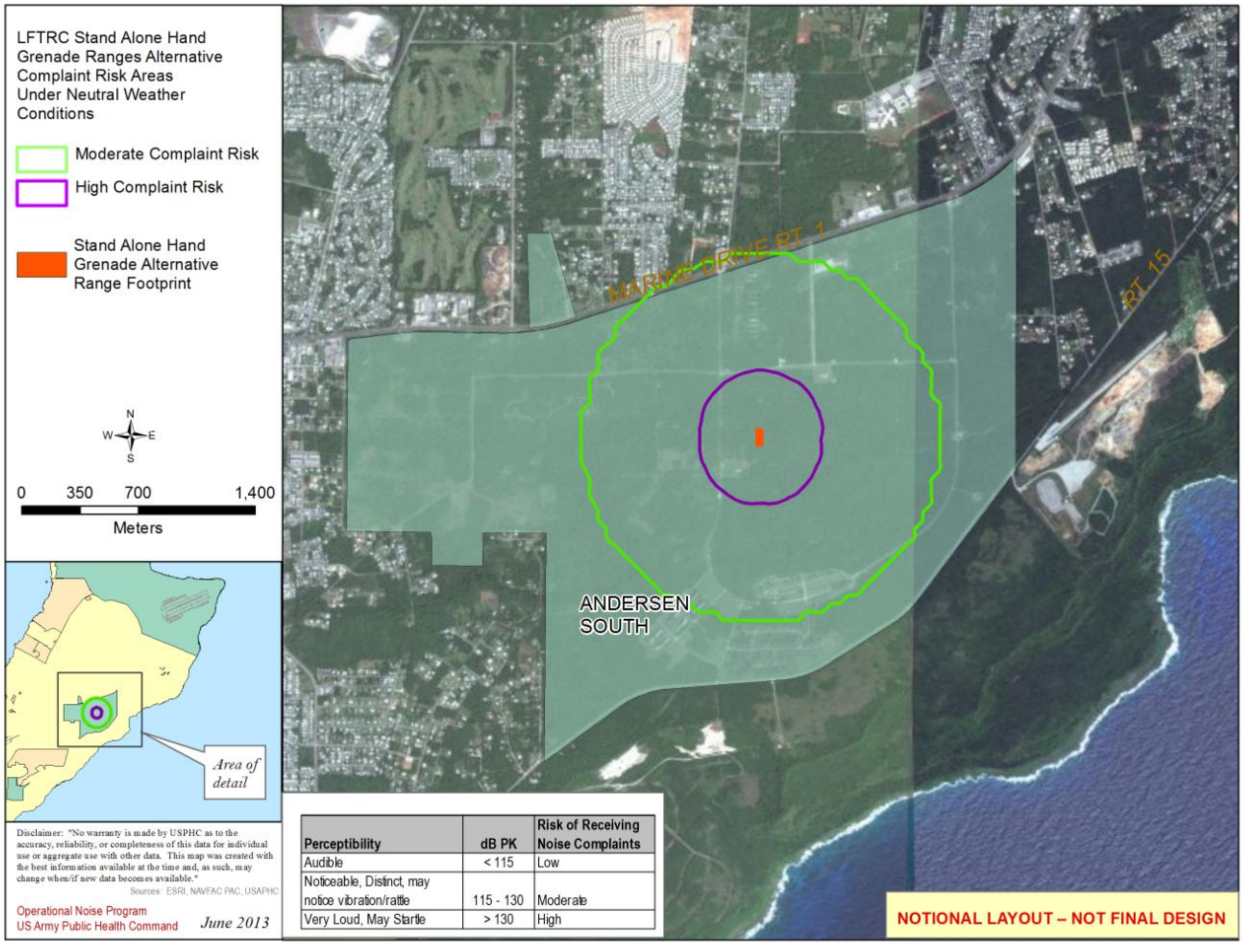


FIGURE 14. PROJECTED HAND GRENADE COMPLAINT RISK AREAS UNDER NEUTRAL WEATHER CONDITIONS

12. CONCLUSIONS.

a. LFTRC Small Caliber Ranges.

(1) NMS-EW Alternative. Although the Noise Zones for the NMS-EW alternative extend beyond the NMS and proposed land expansion area boundaries, the area surrounding the site is undeveloped and does not contain any noise-sensitive land uses. Within the existing NMS property, the Noise Zones do not encompass any noise-sensitive land uses.

(2) NMS-L Alternative. Zone 1 extends beyond the northern boundary from the MPMG Range activity. Even though there are residential properties within the Zone 1 from MPMG Range activity, noise-sensitive land uses within Zone 1 are considered compatible. Within the off-base Zone 2, the land is undeveloped and does not contain any noise-sensitive land uses. Although the Noise Zones for the southern portion of NMS-L alternative extend beyond the boundary, the area surrounding the site is undeveloped and does not contain any noise-sensitive land uses. Within the existing NMS property the Noise Zones do not encompass any noise-sensitive land uses.

(3) NMS-NS Alternative. The Noise Zones for the NMS-NS alternative extend beyond the NMS and proposed land expansion area boundaries. Even though there are residential properties within the off-base Zone 1 from MPMG Range activity, noise-sensitive land uses within Zone 1 are considered compatible. Within the off-base Zone 2, the land is undeveloped and does not contain any noise-sensitive land uses. Within the existing NMS property the Noise Zones do not encompass any noise-sensitive land uses.

(4) NWF Alternative. Under the NWF option, the Noise Zones would be generally contained within the Andersen AFB boundary, the proposed NWF expansion area or DoI land. Along the northeastern coastline Zone 1 and Zone 2 extends beyond the Andersen AFB boundary. Zone 1 encompasses three residential structures. Based on available imagery, the remaining areas within the Noise Zones are undeveloped and do not contain any noise-sensitive land uses. Within Andersen AFB, Zone 1 extends to the Pacific Regional Training Center. Levels above 65 dB ADNL (Zones 2 and 3) do not encompass any existing noise-sensitive land uses on Andersen AFB. However, there is a proposed JTE facility located approximately 250 meters from the proposed MPMG Range. The proposed JTE facility would be within Zone 2 (70-74 dB ADNL). If NWF is selected as the preferred alternative for the LFTRC, consideration for noise level reduction in the building design of the JTE facility may be necessary.

(5) Route 15A Alternative.

(a) The ranges in the northern area of the Route 15A land expansion area generate Noise Zones which extend beyond the land expansion area encompassing residential areas and undeveloped land. Based on available imagery, there are no noise-sensitive land uses within the off-base Zone 3. Zone 2 (65-69 dB ADNL) encompasses approximately 18 residential properties. Zone 2 (70-74 dB ADNL) encompasses four residential properties. Noise-sensitive land uses are discouraged within 65-69 DNL and between 70-74 DNL residential land use is strongly discouraged. Although Zone 1 encompasses multiple residential properties, noise-sensitive land uses are considered compatible within Zone 1.

(b) The ranges in the southern area of Route 15A land expansion area generate Zones 1 and 2 which extend beyond the southern boundary of Andersen South and the Route 15A land expansion area encompassing undeveloped land. Levels above 75 dB ADNL (Zone 3) do not extend beyond the boundary.

(c) The Noise Zones do not encompass any noise-sensitive land uses within Andersen South.

b. LFTRC 40mm Grenade Launcher Activity. There would be a low risk of complaints from the 40mm Grenade activity at any of the proposed LFTRC sites.

c. Proposed Hand Grenade Range Activity. The Noise Zones remaining on base indicate that annual average noise levels from the proposed hand grenade activity are compatible with the surrounding environment. Yet, there is potential for individual events to cause annoyance and possibly generate noise complaints under unfavorable weather conditions.

13. RECOMMENDATIONS. Include the information from this consultation in the appropriate environmental analysis documentation.

Kristy Broska

KRISTY BROSKA
Environmental Protection Specialist
Operational Noise

APPROVED:

Catherine Stewart

CATHERINE STEWART
Program Manager
Operational Noise

APPENDIX A

REFERENCES

1. U.S. Army, 2003, Army Construction Engineering Research Laboratories, SARNAM Computer Model, Version 2.6.2003-06-06.

2. U.S. Army, 2007, Army Regulation 200-1, Environmental Protection and Enhancement, Chapter 14 Operational Noise.

3. U.S. Army, 2009, Construction Engineering Research Laboratories, BNOISE2 Computer Model, Version 2009-11-30.

4. U.S. Marine Corps, 2008, MC Order 3550.11, Range Air Installations Compatible Use Zones, 28 January 2008.

APPENDIX B

GLOSSARY OF TERMS, ACRONYMS & ABBREVIATIONS

B-1. GLOSSARY OF TERMS.

A-weighted Sound Level – the ear does not respond equally to sounds of all frequencies, but is less efficient at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound pressure level of a noise containing a wide range of frequencies in a manner approximating the response of the ear, it is necessary to reduce, or weight, the effects of the low and high frequencies with respect to the medium frequencies. Thus, the low and high frequencies are de-emphasized with the A-weighting. The A-scale sound level is a quantity, in decibels, read from a standard sound-level meter with A-weighting circuitry. The A-scale weighting discriminates against the lower frequencies according to a relationship approximating the auditory sensitivity of the human ear. The A-scale sound level measures approximately the relative "noisiness" or "annoyance" of many common sounds.

Average Sound Level – the mean-squared sound exposure level of all events occurring in a stated time interval, plus ten times the common logarithm of the quotient formed by the number of events in the time interval, divided by the duration of the time interval in seconds.

C-Weighted Sound Level – a quantity, in decibels, read from a standard sound level meter with C-weighting circuitry. The C-scale incorporates slight de-emphasis of the low and high portion of the audible frequency spectrum. It is used when measuring low frequency sound such as those from large arms, demolitions, and sonic booms.

Day-Night Average Sound Level (DNL) – the 24-hour average frequency-weighted sound level, in decibels, from midnight to midnight, obtained after addition of 10 decibels to sound levels in the night from midnight up to 7 a.m. and from 10 p.m. to midnight (0000 up to 0700 and 2200 up to 2400 hours).

Decibels (dB) – a logarithmic sound pressure unit of measure.

Land Use Planning Zone (LUPZ) – DNL noise contours represent an annual average that separates the Noise Zone II from the Noise Zone I.

Noise – any sound without value.

B-2. GLOSSARY OF ACRONYMS AND ABBREVIATIONS.

ADNL	A-weighted average Day Night average Level
BNOISE2	Blast Noise Impact Assessment
cal	caliber
CDNL	C-weighted average Day Night Level
DNL	Day Night Level
DoD	Department of Defense
DoI	Department of Interior
JTE	Joint Threat Emitter
KD	Known Distance
LFTRC	Live-Fire Training Range Complex
mm	millimeter
MPMG	Multi-Purpose Machine Gun
MRFR	Modified Record Fire Range
NAVFAC PAC	Naval Facilities Engineering Command, Pacific
NMS-EW	Naval Munitions Site East-West
NMS-L	Naval Munitions Site L-shaped
NMS-NS	Naval Munitions Site North-South
NWF	Northwest Field
NSSA	Non-Standard Small Arms
RAICUZ	Range Air Installation Compatible Use Zone
SARNAM	Small Arms Range Noise Assessment Model
TP	Training Practice

APPENDIX C

GRENADE LAUNCHER NOISE

C-1. REFERENCES.

a. U.S. Army, 1984, Army Environmental Hygiene Agency, Environmental Noise Assessment No. 52-34-0442-84, Noise Measurement Study, Camp Bullis, Texas, 27 February – 2 March 1984.

b. U.S. Army, 1999, Center for Health Promotion and Preventive Medicine, Health Hazard Assessment Report on the 40mm XM1001 Canister Cartridge for the MK-19 Mod 3 Grenade Machine Gun, No. 69-37-2735-00, November 1999.

C-2. The 40mm is classified as a large caliber round for noise assessment.

Tables C-1 and C-2 contain the complaint risk criterion for the launch noise of the 40mm grenade launchers. The distances and levels listed represent a conservative approach and were calculated based upon the hearing conservation criteria (U.S. Army 1999) and a know measurement (U.S. Army 1984). This data represents the best available scientific quantification for assessing the complaint risk for the launch noise of the 40mm grenade launcher until a detailed noise measurement study is completed.

TABLE C-1. Complaint Risk to the Side of the 40mm Grenade Launcher, Inert* Round

Risk of Complaints	**Distance from Grenade Launcher**	**Noise Level dBP**
Low	> 300 meters^	< 115 dB
Moderate	65 - 300 meters^	115 dB
High	< 65 meters^	>130 dB
Risk of hearing damage for unprotected ears	< 19 meters+	>140 dB

** -- Inert is defined as any round that does not make noise upon impact, such as smoke, illum, TP*
^ – Calculated value
+ – Known value, hearing conservation criteria.

TABLE C-2. Complaint Risk to the Rear of the 40mm Grenade Launcher, Inert* Round

Risk of Complaints	Distance from Grenade Launcher	Noise Level dBP
Low	> 110 meters^	< 115 dB
Moderate	25 - 110 meters^	115 dB
High	< 25 meters^	>130 dB
Risk of hearing damage for unprotected ears	< 7 meters+	>140 dB

** -- Inert is defined as any round that does not make noise upon impact, such as smoke, illum, TP*
^– Calculated value
+– Known value, hearing conservation criteria.

APPENDIX D

SMALL CALIBER NOISE ZONES
NON-DOD ACREAGE

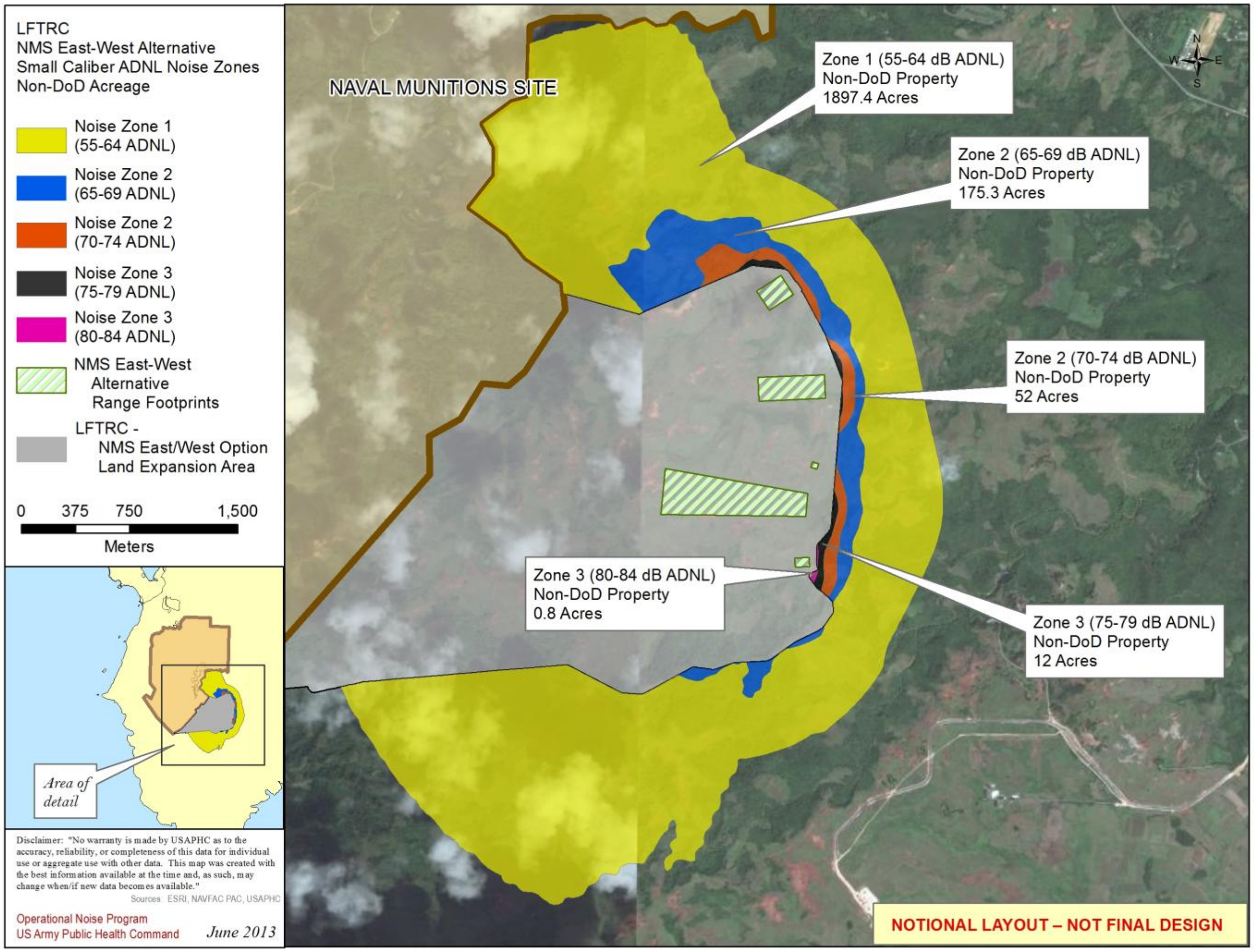


FIGURE D-1. NMS-EW Alternative Small Caliber Noise Zones Non-DoD Acreage

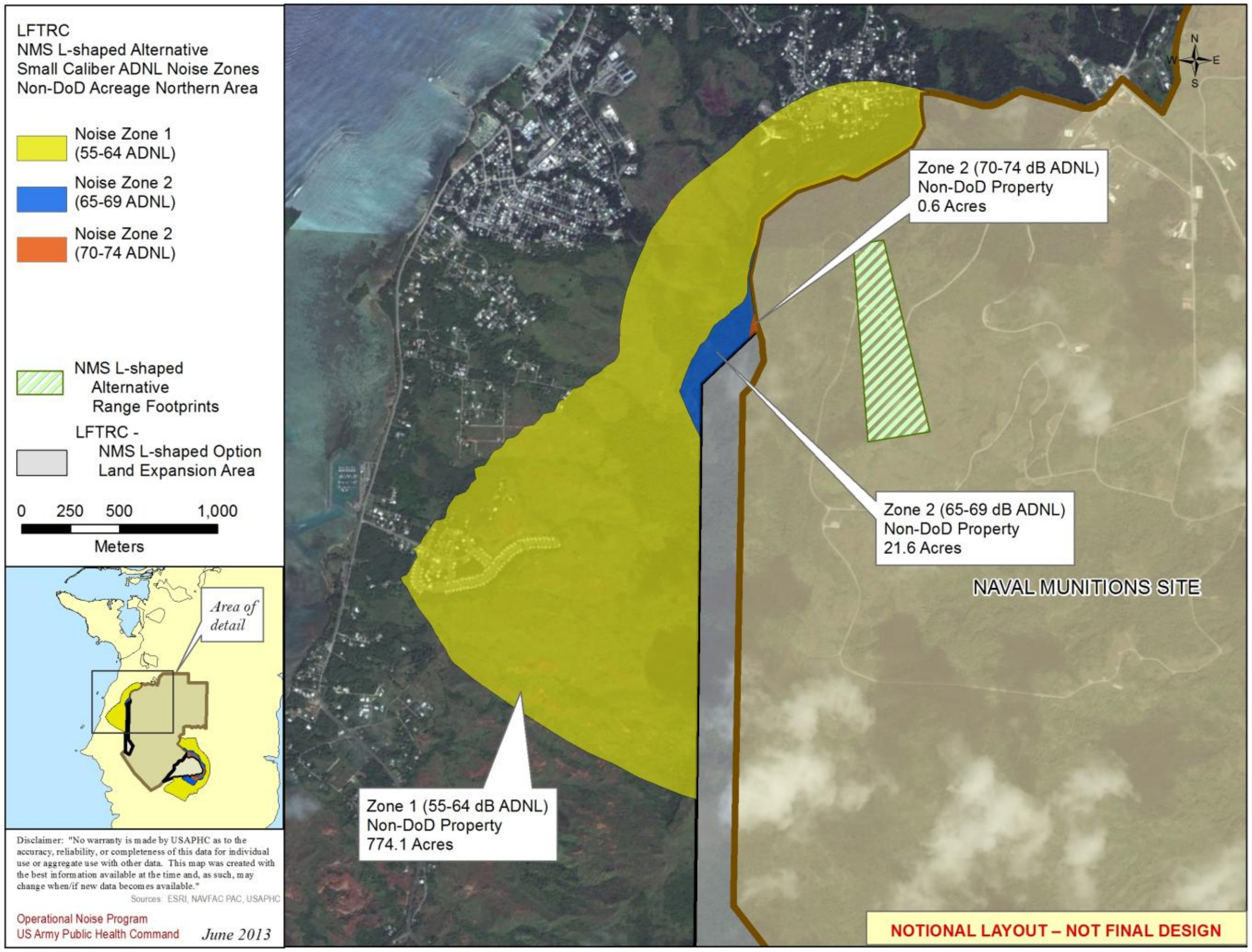


FIGURE D-2. NMS-L Alternative Northern Area Small Caliber Noise Zones Non-DoD Acreage

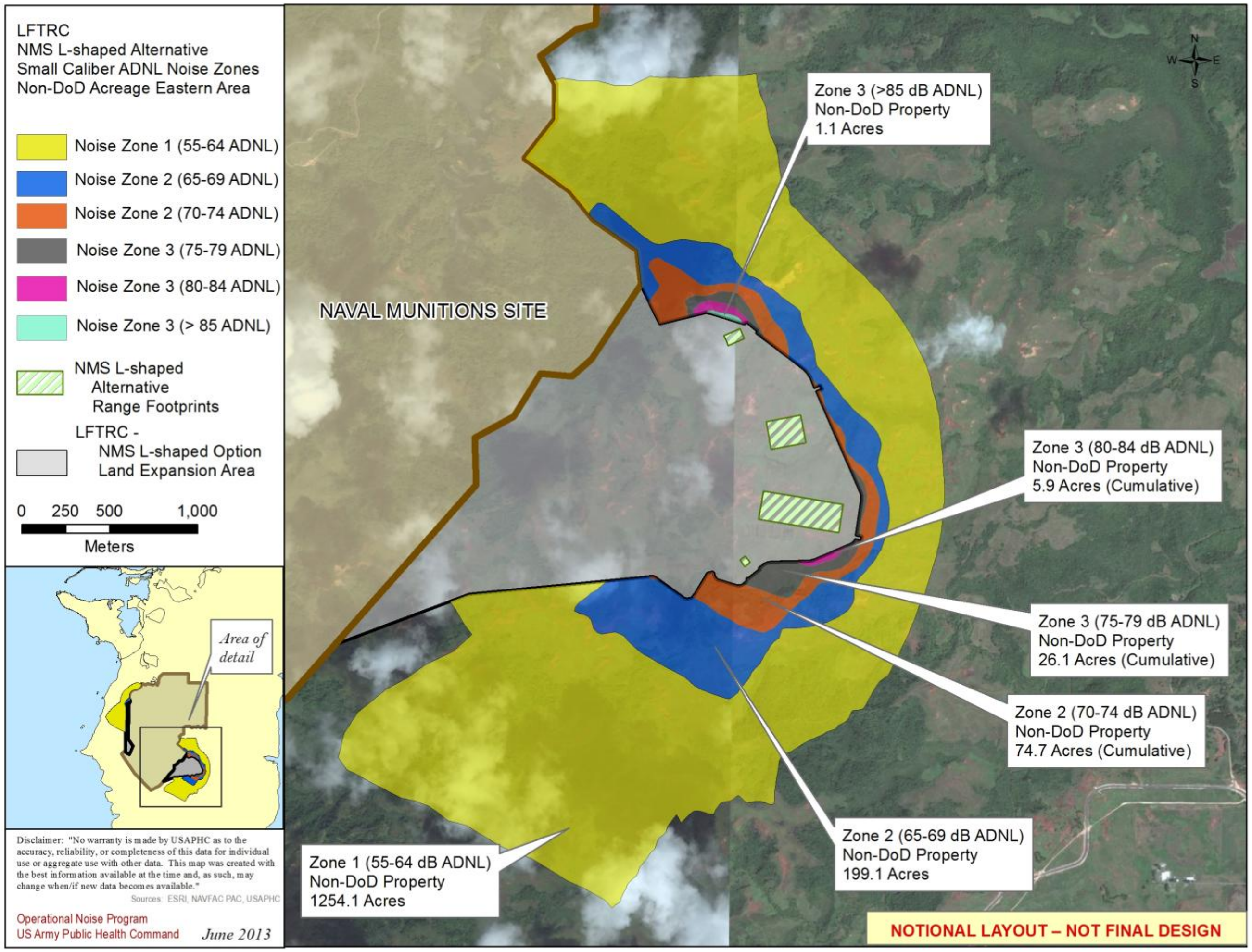


FIGURE D-3. NMS-EW Alternative Eastern Area Small Caliber Noise Zones Non-DoD Acreage

D-4

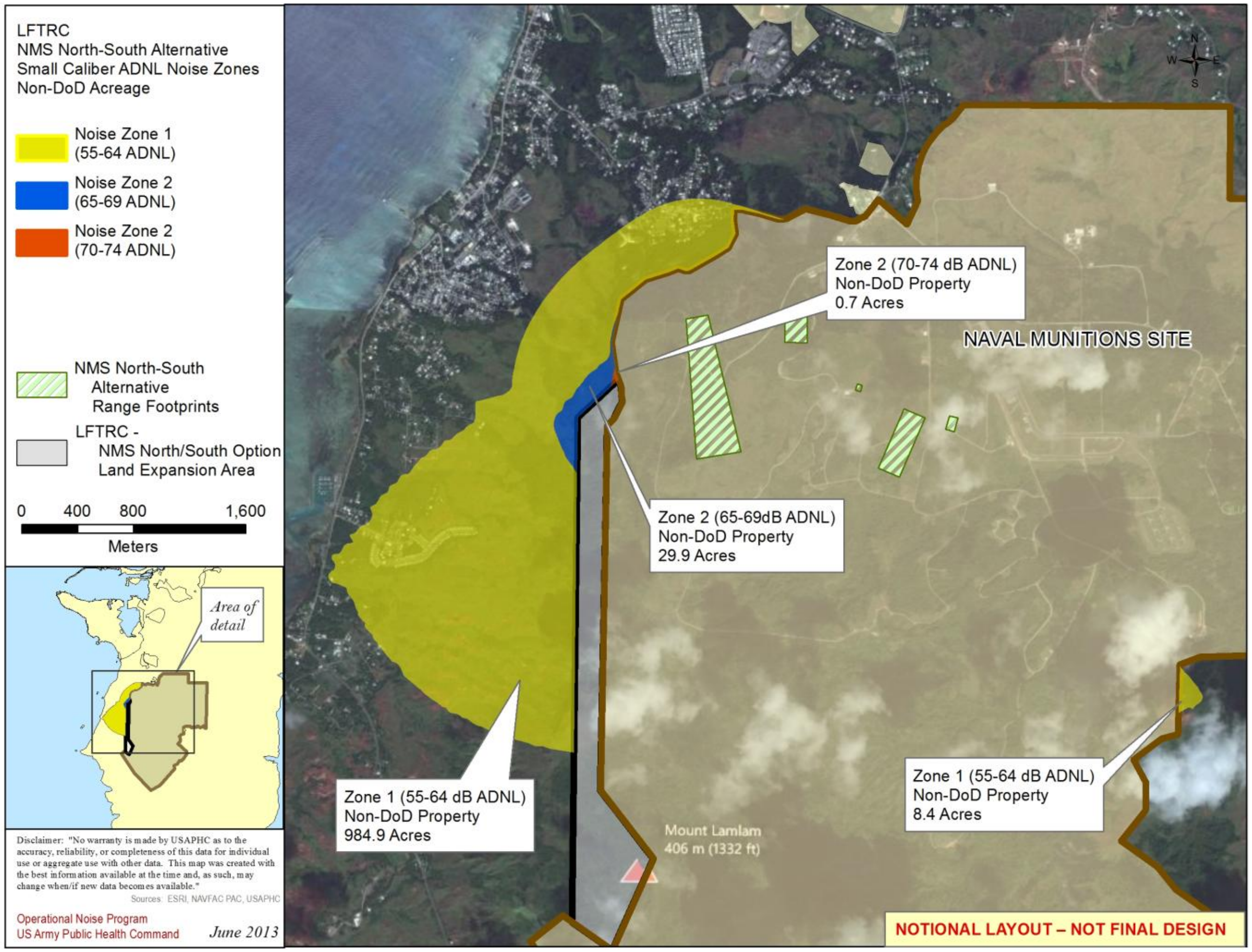


FIGURE D-4. NMS-NS Alternative Small Caliber Noise Zones Non-DoD Acreage

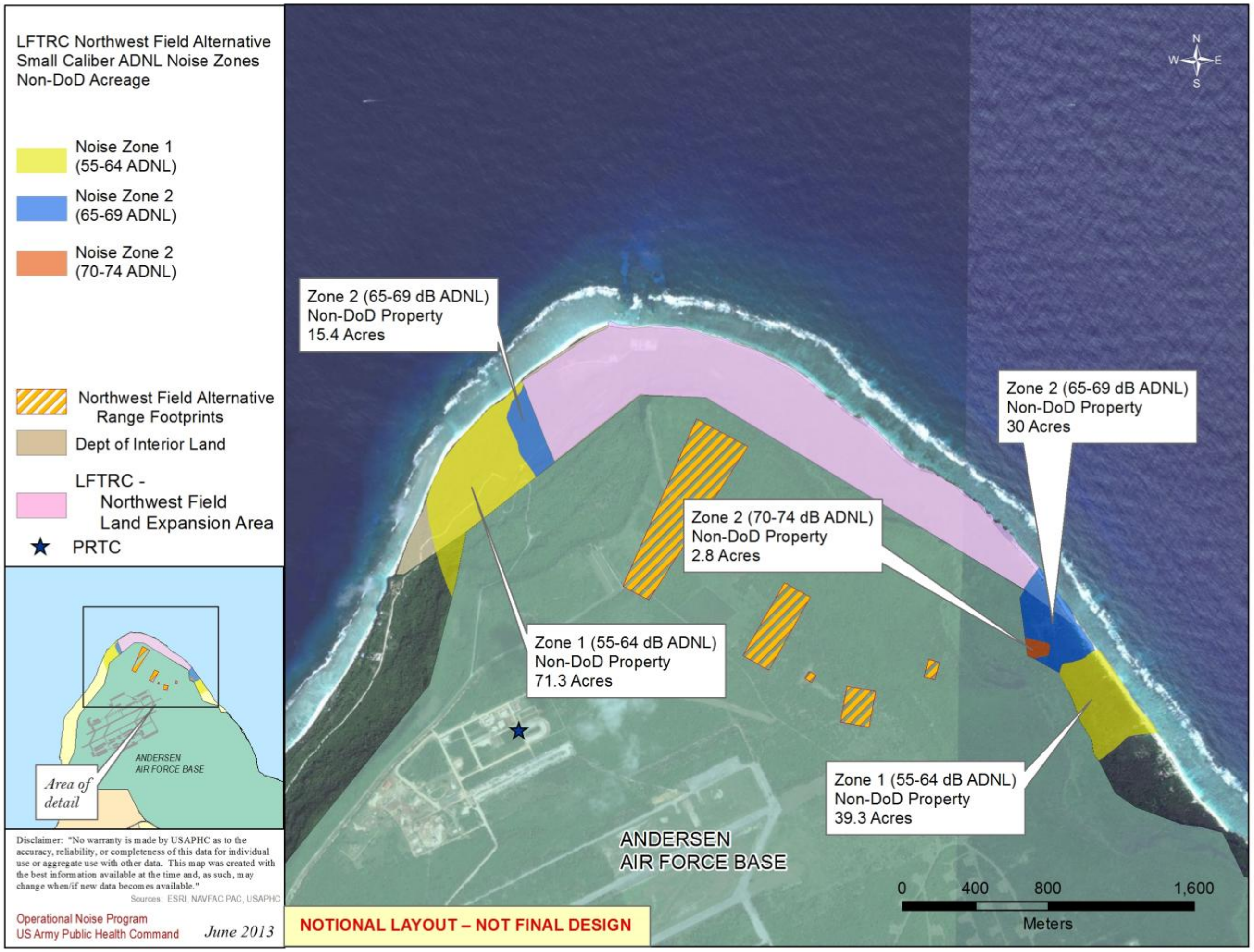


FIGURE D-5. NWF Alternative Small Caliber Noise Zones Non-DoD Acreage

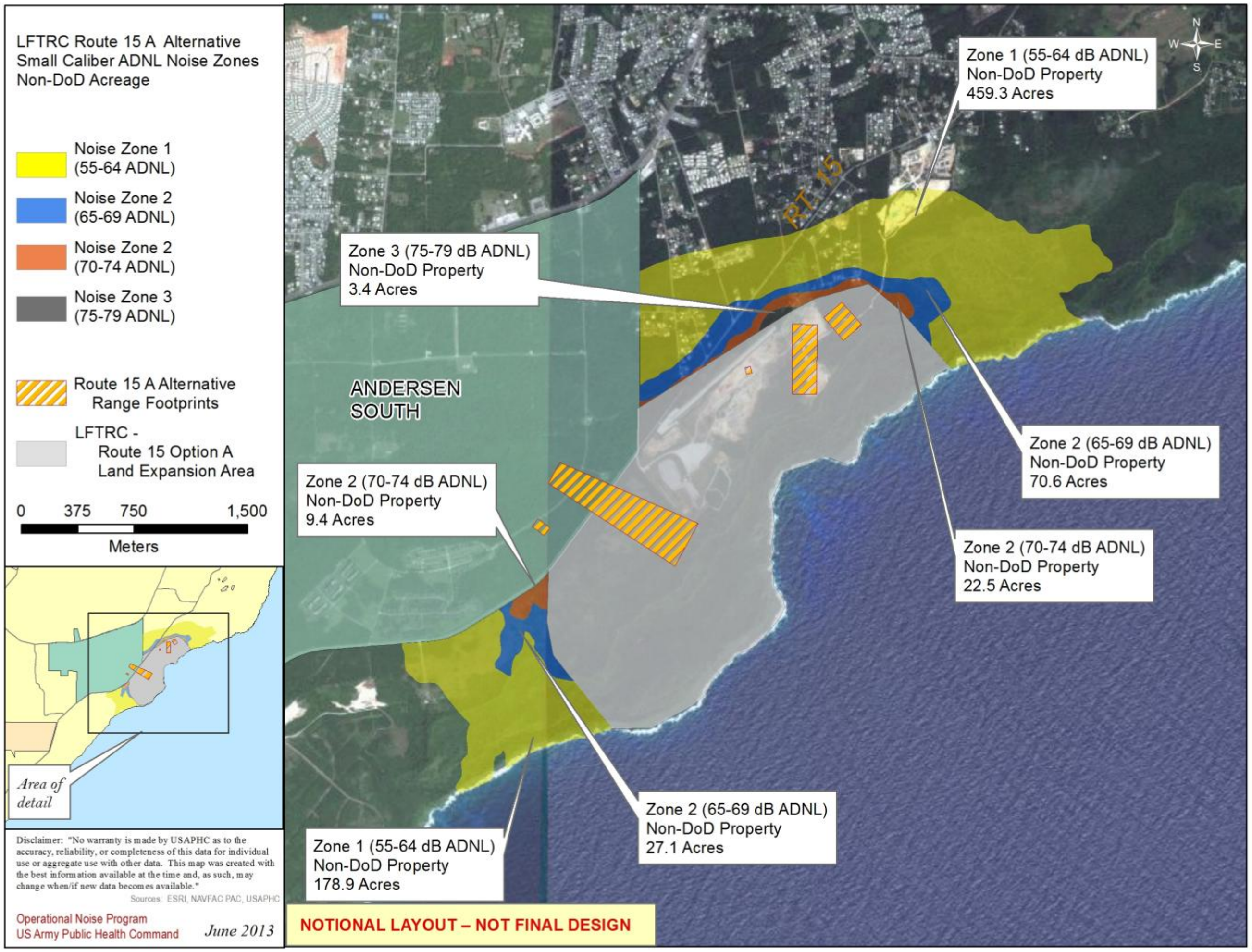


FIGURE D-6. Route 15A Alternative Small Caliber Noise Zones Non-DoD Acreage

Ambient Sound Measurements at Northwest Field Andersen Air Force Base, Guam

Department of the Navy

Prepared by:

Sean Hanser, Naval Facilities Engineering Command, Pacific

Randel Sablan, Joint Guam Project Office

Final Report

March 2015

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Executive Summary

Ambient sound levels were recorded on Northwest Field (NWF) at Andersen Air Force Base (AAFB) between 15 and 22 April 2014 at three recording locations. Two sites were at the edge of the cliff overlooking the Ritidian Unit of the Guam National Wildlife Refuge, and one site was 656 feet (200 meters) back from the cliff edge. Professional-grade Larsen Davis Model 831 sound level meters were used to make the sound measurements. Weather conditions during data collection were mild and warm with relatively low wind, little rain, and high humidity. The purpose of this pilot study was to collect data of representative ambient sound levels near a location of a proposed live fire training range complex (LFTRC) for the Marine Corps' relocation to Guam.

Sound measurements were unweighted sound pressure levels (SPLs), so the results were not adjusted to reflect the biases of human hearing. Measurements were taken that assessed the SPL across the entire spectrum of sound recorded and that broke down the sound spectrum into octave bands. Low-frequency sound (i.e., frequencies <1 kilohertz [kHz] or 1,000 hertz [Hz]) was the greatest and most variable contributor to ambient sound levels. The sources of the low-frequency sound may have been surf and wind. The level of mid-frequency sound was inconsistent from sampling site to sampling site. The source of the mid-frequency sound (i.e., frequencies between 1 and 10 kHz) is undetermined, but may partly be caused by wind in the vegetation. High-frequency sounds (i.e., frequencies >10 kHz) contributed the least to ambient sound, but when transient, elevated broadband sound did occur in the data set, high-frequency octave bands also increased SPL. Some periods of elevated broadband sound at the study sites were correlated with the arrival and departure of fixed and rotary-wing aircraft operating at AAFB, but other periods of elevated sound cannot be explained by aircraft activity.

During the sampling period, there was a persistent acoustic floor at the three sites that was above 65 decibels (dB) a large percentage of the time. Of the three sampling sites, the location within the primary limestone forest had the highest ambient sound levels. At this location, the overall unweighted sound level was virtually never below 50 dB, and above 65 dB almost 100% of the time on some days.

The results of this study are representative of ambient sound levels during mild environmental conditions near the coast of northern Guam. Guam is a location known for heavy rain, persistent wind, and high sea states, all of which contribute to ambient noise. Because of the mild weather during data collection, the results of this study may represent the lower end of ambient sound levels that could occur from environmental factors such as wind, surf, and rain at the edge of NWF.

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Cover photo by Randel Sablan.

List of Acronyms and Abbreviations

AAFB	Andersen Air Force Base
dB	decibel(s)
DON	Department of the Navy
ft	foot/feet
GNWR	Guam National Wildlife Refuge
h	hour(s)
Hz	hertz (also known as cycles per second)
kHz	kilohertz
km	kilometer(s)
LFTRC	live-fire training range complex
L_{dcp}	the average sound level, in dB, for the data collection period
L_{Zeq}	unweighted decibel average SPL of all sounds in a time period
L_{ZFmax}	unweighted maximum SPL evaluated for the time interval since the preceding sample based on the Fast detector
L_n	sound level that is exceeded n% of the measurement time
L_{Zpeak}	unweighted peak SPL evaluated for a time interval since the preceding sample
m	meter(s)
min	minute(s)
mph	miles per hour
ms	millisecond(s)
NWF	Northwest Field
Pt	Point
RMS	root mean square
SLM	sound level meter
SPL	sound pressure level
USFWS	U.S. Fish and Wildlife Service

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Introduction

As part of the U.S. military realignment in the Pacific, the Department of Defense is planning to relocate approximately 5,000 Marines from Okinawa, Japan, to Guam. In support of this plan, the Department of the Navy (DON) is currently analyzing the environmental effects associated with the construction and operation of a proposed live-fire training range complex (LFTRC) on Guam that allows for simultaneous use of all firing ranges to support training and operations of the relocated Marines. The DON has identified a location at Northwest Field (NWF) on Andersen Air Force Base (AAFB) as the preferred alternative for the LFTRC (DON 2014).

The purpose of this project is to measure representative ambient sound pressure levels (SPLs) at NWF under typical current conditions at the proposed LFTRC location on a plateau approximately 360 feet (ft) (110 meters [m]) above and directly south of the Guam National Wildlife Refuge (GNWR). In order to better understand the potential effects of noise associated with the training at the proposed LFTRC and to put those effects in context, it is beneficial to understand what the current expected ambient sound level is in the area. Once the level of ambient sound is quantified, the acoustic floor and the degree of potential masking of sounds from live-fire operations at the LFTRC can be better understood.

Materials and Methods

Measuring Device

Sound level measurements were captured with two Larsen Davis Model 831 sound level meters (SLMs) (firmware version 2.110). The SLMs were left unattended to collect sound measurements over time. To manage battery power and ensure complete samples, the length of time of data collection was limited to 10 hours (h), although SLMs were typically collected before the entire 10 h ran its course.

Measurements collected were unweighted sound levels, known as *Z-weighting*. Z-weighting is essentially a flat weighting curve that does not account for any increased or lost sensitivity to certain frequencies. When the Z-weighting is applied in the Model 831 SLM, the frequencies measured are between 10 hertz (Hz) and 20 kilohertz (kHz) (i.e., 20,000 Hz). Other common weighting schemes that could be used are defined in the Larson Davis SLM manual (PCB Piezotronics, Inc. 2010) as:

- *A-weighting*, which is a filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to low levels of sound. Because human hearing is less sensitive to lower and higher frequencies, A-weighting puts emphasis on the 1 to 4 kHz range, the range of greatest sensitivity in the human ear.
- *C-weighting*, which is a filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to high levels of sound. This weighting is most often used to evaluate noise from heavy equipment or very high SPLs, such as high explosives and sonic booms.

Because A-weighting and C-weighting are filters that apply to human hearing, applying those weighting schemes would present sound levels that may not be representative of SPLs as they would be perceived by other detectors, mechanical or biological. The difference between each weighting system is well defined, so conversion from one weighting filter to another is relatively simple when the data presented are measured in octave bands, as the SLMs did for this study.

The SLMs had optional data logging firmware installed that would record the sound level measurements at specified intervals over time. The SLMs were set to record data in 5-minute (min) intervals throughout the 10-h data collection period. For continuous sounds, the focus of this study, the SLM could be set to detect or respond to sounds with two response speeds: *slow* for which the response time is 1 second (1,000 milliseconds [ms]) and *fast* for which the time constant is 1/8 second (125 ms). The Slow, or *S*, detector is commonly used in environmental sound measurements. The Fast detector, or *F*, is a less commonly used weighting but will detect changes in sound level more rapidly. Because this study focused on measuring significant changes in SPL over time instead of smoothing sound level measures from one time period to the next, the internal detectors in the SLMs were set to the Fast detector. The detector settings within the SLMs were also set to linear integration instead of exponential integration. Exponential detectors can hide small changes in sound level in the long decay of a loud impulsive event, while linear detectors integrate energy that only occurs during a given limited time period.

The measurements reported at each 5-min interval are summarized as follows:

L_{Zeq}	An integrated SPL across the sound spectrum using the unweighted filter evaluated for the time interval (5 min) since the preceding sample. This can be thought of as an "average" SPL over the past 5 minutes.
L_{Zpeak}	The maximum or peak SPL evaluated for the time interval since the preceding sample using the unweighted filter.
L_{ZS}	The instantaneous SPL measured at each time interval based on the Slow detector using the unweighted filter.
L_{ZSmax}	The maximum SPL evaluated for the time interval since the preceding sample based on the Slow detector using the unweighted filter.
L_{ZSmin}	The minimum SPL evaluated for the time interval since the preceding sample based on the Slow detector using the unweighted filter.
L_{ZF}	The instantaneous SPL measured at each time interval based on the Fast detector using the unweighted filter.
L_{ZFmax}	The maximum SPL evaluated for the time interval since the preceding sample based on the Fast detector using the unweighted filter.
L_{ZFmin}	The minimum SPL evaluated for the time interval since the preceding sample based on the Fast detector using the unweighted filter.

Additional optional data logging firmware installed in the SLMs included the Octave Band Analyzer which report SPLs in 1-octave and 1/3-octave bands across the frequency spectrum. Collecting frequencies into discreet bins of single-octave or 1/3-octave bands is a standard practice for reporting SPLs. It makes a large amount of complex data easier to understand while breaking down the SPLs across the spectrum into groups of related frequencies instead of reporting one integrated measure across the spectrum, such as L_{Zeq}. Because the Fast detector was the preferred setting of the SLMs, Octave Band Analyzer levels are reported as L_{ZF}, L_{Zeq}, L_{ZFmax}, and L_{ZFmin}.

Aside from peak measurements, all other measurements are a statistical measurement given as root mean square (RMS). This is a standard way of measuring sound levels in acoustical science. RMS is a measure that is used to characterize the magnitude of a varying quantity, such as a sinusoidal wave, which is what sound is. Simply stated, RMS is the square root of the mean of the squares of the measured values. The RMS level is 0.707 times the peak sound level.

The SLMs also automatically make some measurements of sound more often than once every 5 minutes. To determine broadband statistics, the sound level is sampled every 10 ms. These measurements allow the SLMs to calculate a widely used parameter called L_n, which represents a sound level which is exceeded n% of the measurement time. For example, L_{90} is the level of sound that is exceeded 90% of the time. To calculate broadband statistics, the sound level is divided into 0.1-decibel (dB) wide amplitude classes over a 199-dB span. The resulting table, from which all values of L_n between $L_{0.01}$ to $L_{99.99}$ can be calculated, is referred to as the distribution table.

Calculated Sound Measures

For each data collection period, a time-average sound level was calculated using the equation:

$$L_{dcp=10\log_{10}}\left[(1/n)\sum_{i=1}^{n}10^{0.1L(i)}\right]$$

where L_{dcp} is the average sound level, in dB, for the data collection period; n is the number of measurements within the data collection period, and $L(i)$ is the ith measure of sound level during the data collection period (Yeager and Marsh 1998). The equation is an adapted form of the equation used for calculating sound level measures such as the Day Average Sound Level or the Night Average Sound Level, but those average sound levels use agreed-upon periods of sound measurement (15 hours for the Day Average Sound Level and 9 hours for the Night Average Sound Level) (Yeager and Marsh 1998). Whereas the periods of sound measurement for this study are defined by the period that SLMs were collecting data. L_{dcp} was calculated for L_{Zeq}, L_{Zpeak}, and L_{ZFmax} for both broadband SPLs and octave bands.

Applying L_{dcp} to peak and maximum SPLs should be interpreted with caution because time-average sound levels are a form of equivalent-continuous sound levels that assume there is no time-weighting involved in the sound level measures being used. Peak and maximum SPLs record the single maximum value that occurred during the time interval (a 5-min interval in this study). Clearly, the sound during the interval is not being treated as continuous. Therefore, L_{dcp} values for peak and maximum values are the most mathematically correct way to represent the average peak or maximum sound level value, but they should not be interpreted as the actual average sound level that occurred during a data collection period.

Measures of spread, such as standard error or standard deviation, cannot be applied to the sound measurements within the data collection periods, because the assumptions about the data necessary to calculate those statistics are violated by the series of sound measurements in a data collection period. Standard error or standard error require independent, identically distributed data in order to be unbiased estimates. The SPLs collected are a time series and each measurement is not independent of the previous measurement; therefore, they are not independent.

Data Collection Locations

The data collection locations were near the edge of the cliff at NWF above the Ritidian Unit of the GNWR. Three locations were used at various times to record data between 15 and 22 April 2014. For the purposes of this report, the locations are named Cliff Edge, Ritidian Point (Pt) #1, and Ritidian Pt #2. The locations are marked as stars on Figure 1. Cliff Edge was located in primary limestone forest at the edge of the cliffline above the GNWR. The Ritidian Pt #1 site was located at the end of the maintenance road that leads to a concrete pad on the cliff edge above the U.S. Fish and Wildlife Service (USFWS) offices at the GNWR. Ritidian Pt #2 was located on the maintenance road about 656 ft (200 m) south of Ritidian Pt #1. These locations were used for the study because of their proximity to the proposed LFTRC and the GNWR. The Cliff Edge site would be within the proposed LFTRC and was directly above the GNWR. The Ritidian Pt #1 and #2 sites would be at the western edge of the proposed LFTRC and above the USFWS Office at GNWR.

The SLMs were mounted on a tripod or placed in a suitable stable location and left unattended. They were protected with a plastic bag around the body of the unit. A microphone wind screen that is designed for use with the SLMs was used because it eliminates noise that would occur from wind directly blowing on or across the microphone. Wind sound that is ambient in the environment, such as wind passing through trees, is still measured by the SLM. Figure 2 shows the SLMs set up at the Cliff Edge and Ritidian Pt #1 sites.

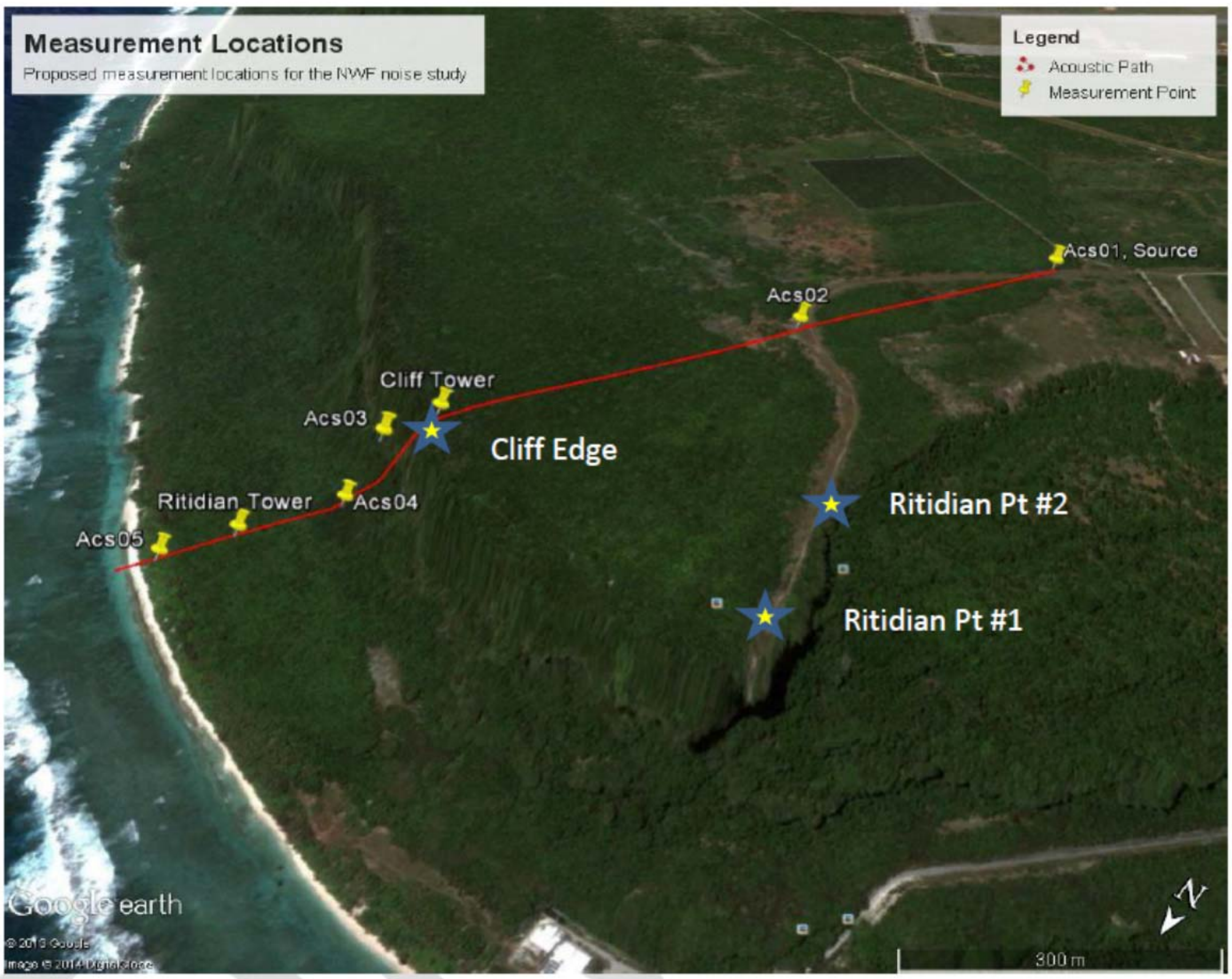


Figure 1. A Google Earth Image of Data Collection Sites at NWF

The three locations for obtaining sound level measurements are marked with stars. The red line marks a notional path that sound would travel from a theoretical firing point for a firing range. The yellow markers are potential locations where sound could be measured along a sound path.

Figure 2. SLMs at Two Data Recording Locations

Figure 2A. SLM at Cliff Edge – the wind screen is the large black ball on the end of the SLM; it covers the microphone, which was not covered by the plastic bag. Figure 2B. SLM at Ritidian Pt #1 – because it was a location that was easily accessible, the equipment was marked with pink tape to warn AAFB personnel. The tripod was secured to the railing post. Photos by Randel Sablan.

Results

Ambient sound was recorded between 15 and 22 April 2014 at the three recording locations. Table 1 reports the periods of data collection for each site. The majority of data collection occurred at Cliff Edge and Ritidian Pt #1. The one data collection session at Ritidian Pt #2 was opportunistic and was made shorter due to concerns about the SLM's battery life.

Table 1. Details on Data Collection by Location

Date	Time	Duration	Comment
Cliff Edge			
15 April	11:16 – 18:28	N/A	Data not recorded for undetermined reason
15-16 April	18:31 – 04:21	9 h 50 mins	May have shut down due to low battery
17 April	10:32 – 20:32	10 h 00 mins	
22 April	08:29 – 16:10	7 h 41 mins	Stopped by operator
Ritidian Pt #1			
15 April	10:23 – 17:37	07 h 14 mins	Stopped by operator
15-16 April	19:24 – 05:24	10 h 00 mins	
16 April	07:48 – 17:41	09 h 53 mins	Stopped by operator
17 April	09:32 – 19:32	10 h 00 mins	
22 April	09:19 – 16:43	7 h 22 mins	Stopped by operator
Ritidian Pt #2			
16 April	09:18 – 17:34	8 h 16 mins	Stopped by operator

Weather Conditions

Historical weather data were obtained from Weather Underground (www.wunderground.com) and were available only for Agana, Guam. The data are presented in Table 2 and Figures 3 through 6. The weather on collection days was primarily sunny with relatively high humidity, moderate to low wind, and infrequent rain.

Table 2. Weather Conditions, Agana, Guam, on Data Collection Days

Date	Min Temp (°F/°C)	Max Temp (°F/°C)	Avg Temp (°F/°C)	Avg Humidity (%)	Precipitation (in/cm)	Avg/Max Wind Speed (mph [kph])
15 April	77/25	90/32.2	84/28.9	86	0.79/2.00	3/12 (4.8/19.3)
16 April	78/25.6	91/32.8	84/28.9	80	0/0	6/14 (9.7/22.5)
17 April	79/26.1	91/32.8	85/29.4	77	0.04/0.10	8/14 (12.9/22.5)
22 April	81/27.2	88/31.1	84/28.9	74	0.01/0.03	10/14 (16.1/22.5)

Notes: Avg = average, °C = degrees Celsius, cm = centimeters, °F = degrees Fahrenheit, in = inches, kph = kilometers per hour, Max = maximum, Min = minimum, mph = miles per hour, Temp = temperature.
Source: www.wunderground.com.

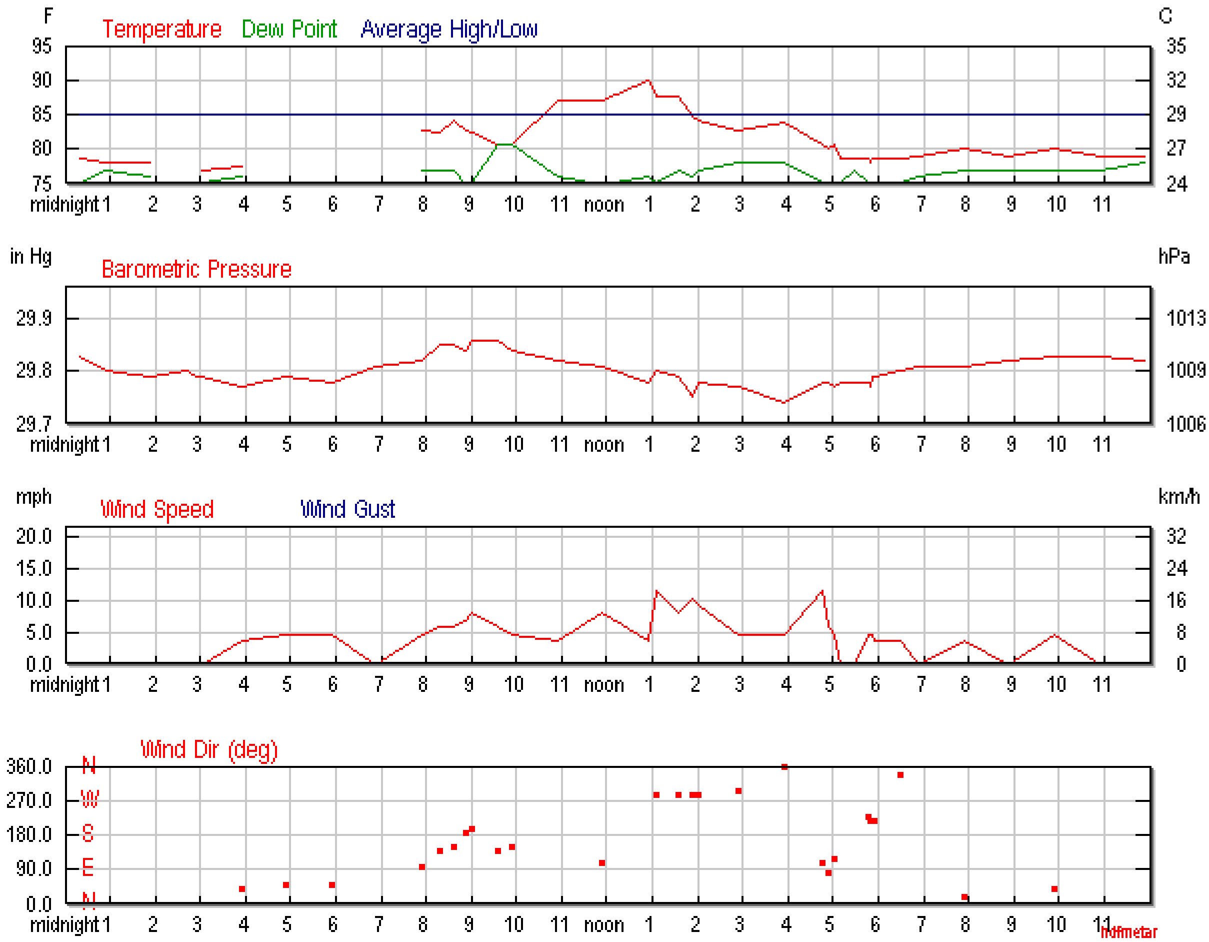


Figure 3. Weather Conditions in Agana, Guam, on 15 April 2014

Notes: Rain and thunderstorms occurred between approximately 14:30 and 19:00.

Legend: Time is on the x-axis.

Temperature: F = degrees Fahrenheit, C = degrees Celsius.

Barometric Pressure: in Hg = inches of mercury, hPa = hectopascal.

Wind Speed: mph = miles per hour, km/h = kilometers per hour.

Wind Direction: deg = degrees.

Source: www.wunderground.com.

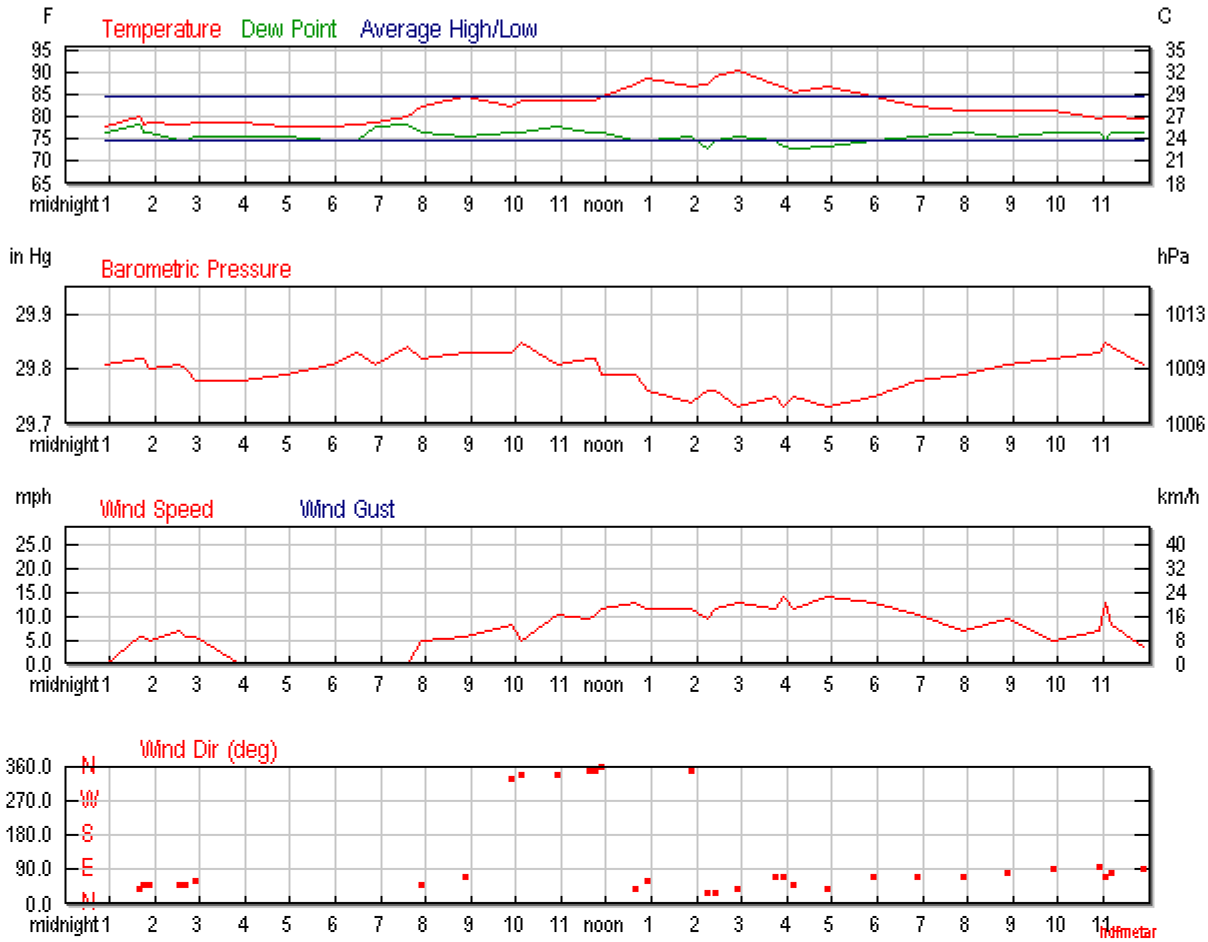


Figure 4. Weather Conditions in Agana, Guam, on 16 April 2014

Legend: Time is on the x-axis.

Temperature: F = degrees Fahrenheit, C = degrees Celsius.

Barometric Pressure: in Hg = inches of mercury, hPa = hectopascal.

Wind Speed: mph = miles per hour, km/h = kilometers per hour.

Wind Direction: deg = degrees.

Source: www.wunderground.com.

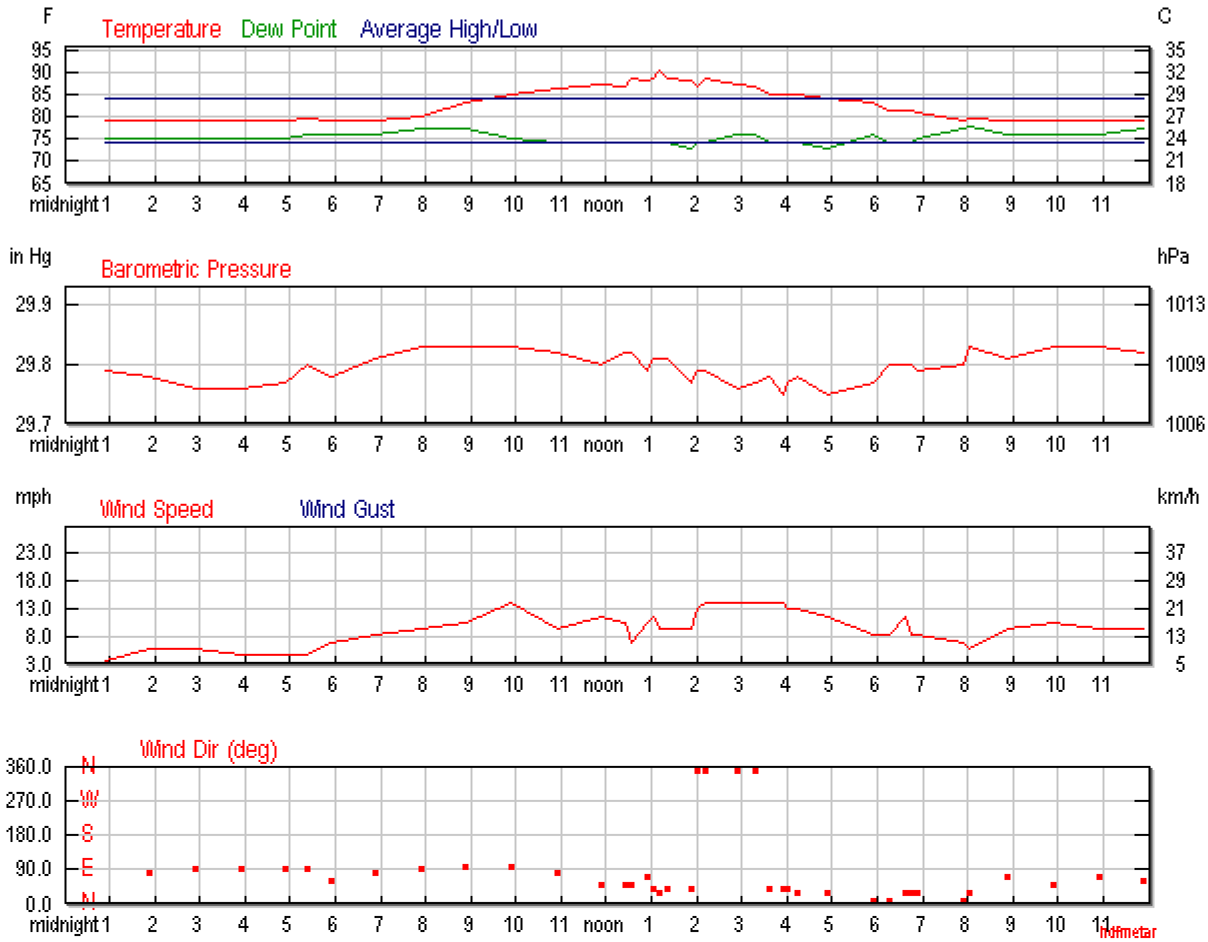


Figure 5. Weather Conditions in Agana, Guam, on 17 April 2014

Note: A small amount of rain occurred around 06:00 and 20:00.

Legend: Time is on the x-axis.

Temperature: F = degrees Fahrenheit, C = degrees Celsius.

Barometric Pressure: in Hg = inches of mercury, hPa = hectopascal.

Wind Speed: mph = miles per hour, km/h = kilometers per hour.

Wind Direction: deg = degrees.

Source: www.wunderground.com.

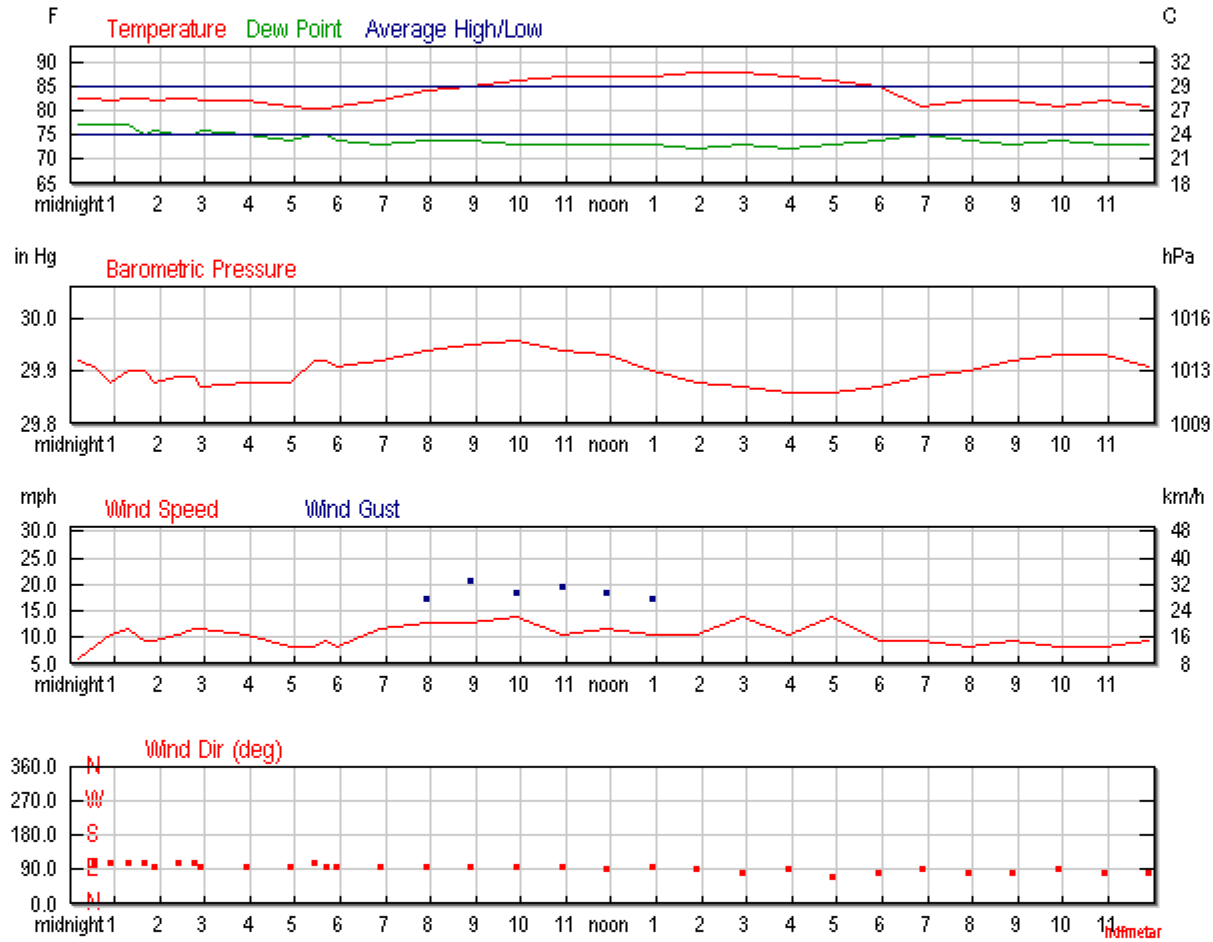


Figure 6. Weather Conditions in Agana, Guam, on 22 April 2014

Note: Wind gusts of 15-21 mph occurred between approximately 08:00 and 13:00.

Legend: Time is on the x-axis.

Temperature: F = degrees Fahrenheit, C = degrees Celsius.

Barometric Pressure: in Hg = inches of mercury, hPa = hectopascal.

Wind Speed: mph = miles per hour, km/h = kilometers per hour.

Wind Direction: deg = degrees.

Source: www.wunderground.com.

Ambient Sound Measurements

Although the SLMs collect a variety of measures of sound (defined in the *Materials and Methods* section of this report), the analysis of the data focuses on three SPL measures (L_{Zeq}, L_{Zpeak}, and L_{ZFmax}) and L_n values associated with the distribution table. These measures are displayed in two different graphical representations, line graphs and histograms, to make the changes in sound level across time more clear. The same graphical representations are provided for each day to be able to compare data between days.

Summary Sound Level Measurements

Synoptic values for sound measurements within a data collection period can provide a general sense of the acoustic environment during that period. Tables 3 and 4 contain the minimum, maximum, and average sound level for each data collection period *(L_{dcp})* for L_{Zeq} and L_{Zpeak}. Data collection periods for each day are shown in Table 1.

Table 3. Summary L_{Zeq} Values for the Various Data Collection Periods

	15 April	Night of 15-16 April	16 April	17 April	22 April
	Ritidian Pt #1				
min	46.71	26.31	58.48	67.39	63.35
max	75.99	71.67	83.66	84.16	76.79
L_{dcp}	65.38	58.26	75.53	75.92	70.82
	Ritidian Pt #2				
min	-	-	49.52	-	-
max	-	-	63.60	-	-
L_{dcp}	-	-	56.99	-	-
	Cliff Edge				
min	-	56.17	-	73.99	71.84
max	-	78.28	-	90.84	79.91
L_{dcp}	-	66.11	-	83.03	75.90

Values are in dB. A dash in a cell indicates that data were not taken in that location at that time.

Table 4. Summary L_{Zpeak} Values for the Various Data Collection Periods

	15 April	Night of 15-16 April	16 April	17 April	22 April
	Ritidian Pt #1				
min	70.49	58.49	79.74	88.88	87.07
max	97.29	95.83	108.61	112.46	107.30
L_{dcp}	87.75	82.52	100.51	101.97	96.51
	Ritidian Pt #2				
min	-	-	70.35	-	-
max	-	-	86.70	-	-
L_{dcp}	-	-	79.59	-	-
	Cliff Edge				
min	-	71.65	-	94.91	92.81
max	-	100.62	-	114.20	105.74
L_{dcp}	-	86.13	-	105.03	98.55

Values are in dB. A dash in a cell indicates that data were not taken in that location at that time.

The data show that at Ritidian Pt #1, the night of 15-16 April was generally quieter than the day before and after. At the times when data were collected simultaneously at Cliff Edge and Ritidian Pt #1, the Cliff Edge site experienced higher SPLs than Ritidian Pt #1. On the one day when data were collected simultaneously at Ritidian Pt #1 and Ritidian Pt #2, Ritidian Pt #1 experienced higher SPLs than Ritidian Pt #2. These overall patterns were true for L_{Zeq} and L_{Zpeak} measures. At Ritidian Pt #1 and Cliff Edge, the average sound level for L_{Zeq} was above 65 dB during daylight hours. Even at night on 15-16 April, the average sound level for L_{Zeq} was above 65 dB at Cliff Edge.

15 April 2014

Sound data were only obtained from Ritidian Pt #1 during the day on 15 April, because of an undetermined technical problem with the SLM at Cliff Edge. Figure 7 is a graph of L_{Zeq} and L_{Zpeak} across the sample period. In this case, the graphed values represent a balance of all of the frequencies across the spectrum from 10 Hz to 20 kHz. Figure 7 also shows arrival and departure events for aircraft at AAFB.

Peak values are expected to be higher than L_{Zeq} values, by definition, but peak SPLs can be highly transient and, at least for mammalian hearing, is not as relevant to the overall impression of sound levels as the integrated SPL over time. Mammals have various physiological and behavior responses that can reduce the effects of short, loud sound. Overall, it appears that some aircraft events may correlate with higher overall ambient sound levels, such as the two departures between 16:00 and 17:00 or the arrival and departure at about 12:20 and 13:00 respectively. Other aircraft events do not correlate with elevated ambient sound levels such as the two arrivals and two landings between 14:00 and 16:00.

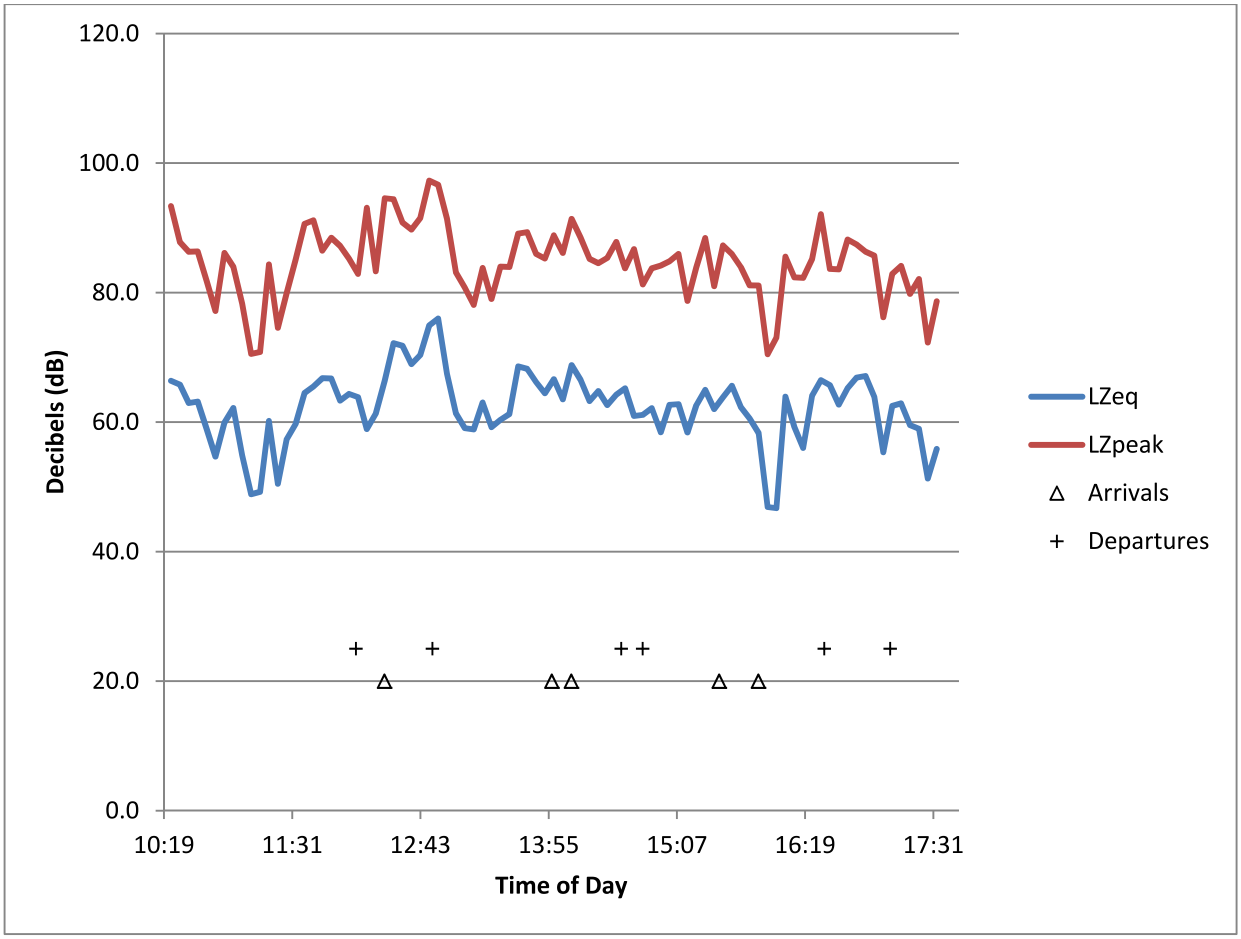


Figure 7. Unweighted Sound Levels (L_{Zeq} and L_{Zpeak}) Across the Frequency Spectrum for 5-minute Samples at Ritidian Pt #1 on 15 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

The L_{Zeq} line on Figure 7 illustrates that general ambient sound levels in the vicinity of Ritidian Pt. #1 were above and below 60 dB throughout the daylight hours. Figure 8 shows a histogram of the values from the distribution table. The x-axis is divided into 5-dB bins of sound levels. The data for the distribution table are measured at a finer time scale than the SPLs for the line graphs (every 10 ms vs. every 5 min), so the data in Figure 7 and Figure 8 may not appear congruent, but the integration across 5-min intervals reduces some of the small-scale variation in the data. The distribution table data appear to be normally distributed with SPLs of $\geq$60 dB being recorded 30.18% of the time. SPLs of $\geq$65 dB occurred 16.87% of the time.

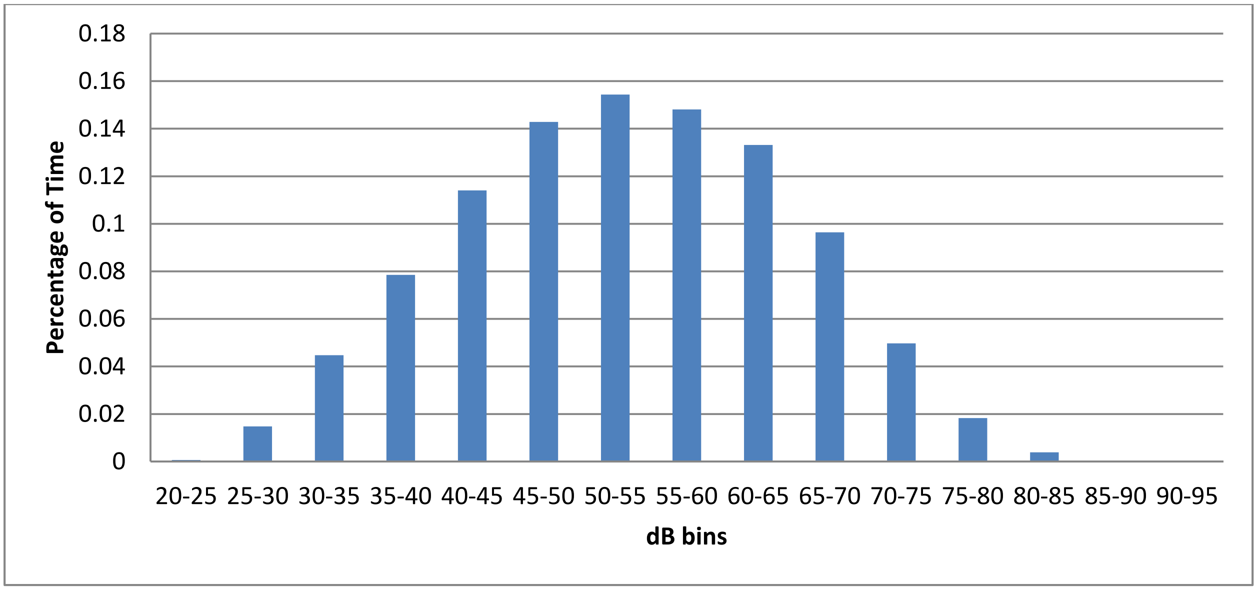


Figure 8. Histogram of the Proportion of Time Sound Levels Were Recorded at Ritidian Pt #1 on 15 April 2014 between 10:23 and 17:37

The data in Figures 7 and 8 give a general impression of the overall sound at Ritidian Pt #1, but they only tell part of the story. The general SPL does not provide a sense of what frequencies are contributing most to the overall sound. In order to get a better sense of what kind of sound is heard at Ritidian Pt #1, the SPLs were measured in octave bands. Figure 9 is a graph of L_{Zeq} values for each octave band within the spectrum of the SLMs' recording capabilities. The rainbow scale was used to represent different frequency octave bands with warm colors representing lower frequencies and cool colors representing higher frequencies. Figure 10 is the same type of graph for L_{ZFmax} for each octave band. The overall SPLs will appear to be lower than the values in Figure 7 because the SPLs are no longer all of the frequencies put together, but are instead broken down into smaller groups of related frequencies.

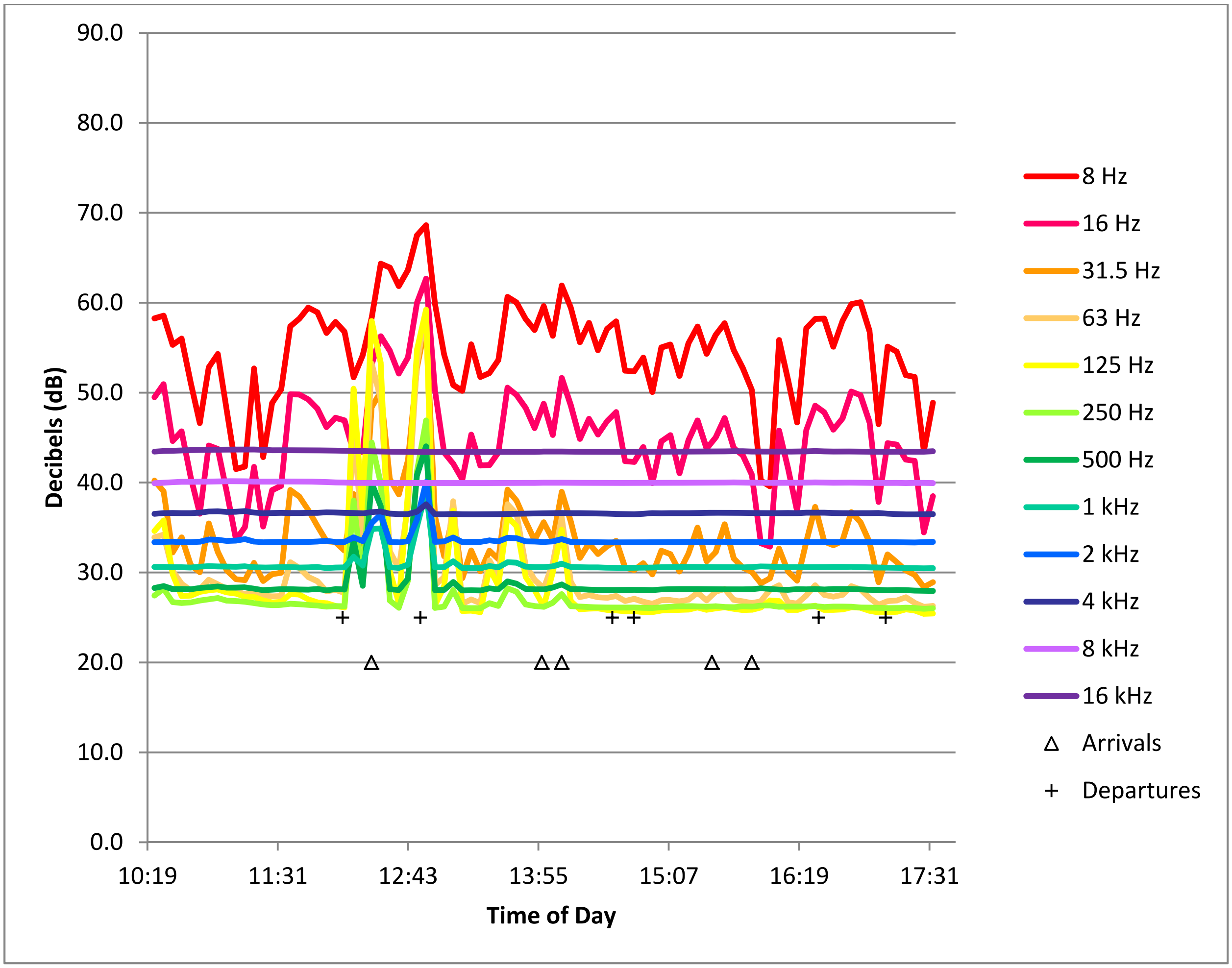


Figure 9. Unweighted Sound Levels (L_{Zeq}) for Octave Bands Integrated Across 5-minute Sample Periods at Ritidian Pt #1 on 15 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Figures 9 and 10 show that higher SPLs occur in the lower frequencies, between the octave bands centered on 8 Hz and 31.5 Hz for most of the day. This type of low frequency sound can come from many sources including waves, wind, and traffic. There is a period around the middle of the day, starting abruptly in the 5-min sample recorded at 12:23 and ending in the 5-min sample recorded at 12:58 when broadband sound up to the 2-kHz octave band shows an elevation in the SPL. The elevations in sound across the spectrum correlate with two departure and one arrival event for aircraft at AAFB. Before and after the period of greater broadband sound there were shorter periods of broadband sound that did not reach the same levels as the midday period. The shorter periods of broadband sound are easier to discern from the L_{ZFmax} values in Figure 10, than the L_{Zeq} values in Figure 9. The slight increase at 14:08 correlates with an aircraft arrival, but some of the other periods of elevation, like at the beginning of the recording or at 13:38, do not appear to correspond with aircraft activity. The period of elevated ambient sound after 16:00 is not broad spectrum and does not seem related to aircraft activity either. Figure 10 shows that the elevated sound levels after 16:00 are primarily in the lower frequencies and not broad spectrum. The peak values also show that there is a contribution to the broadband sound from the 4-kHz octave band that is much less evident in Figure 9.

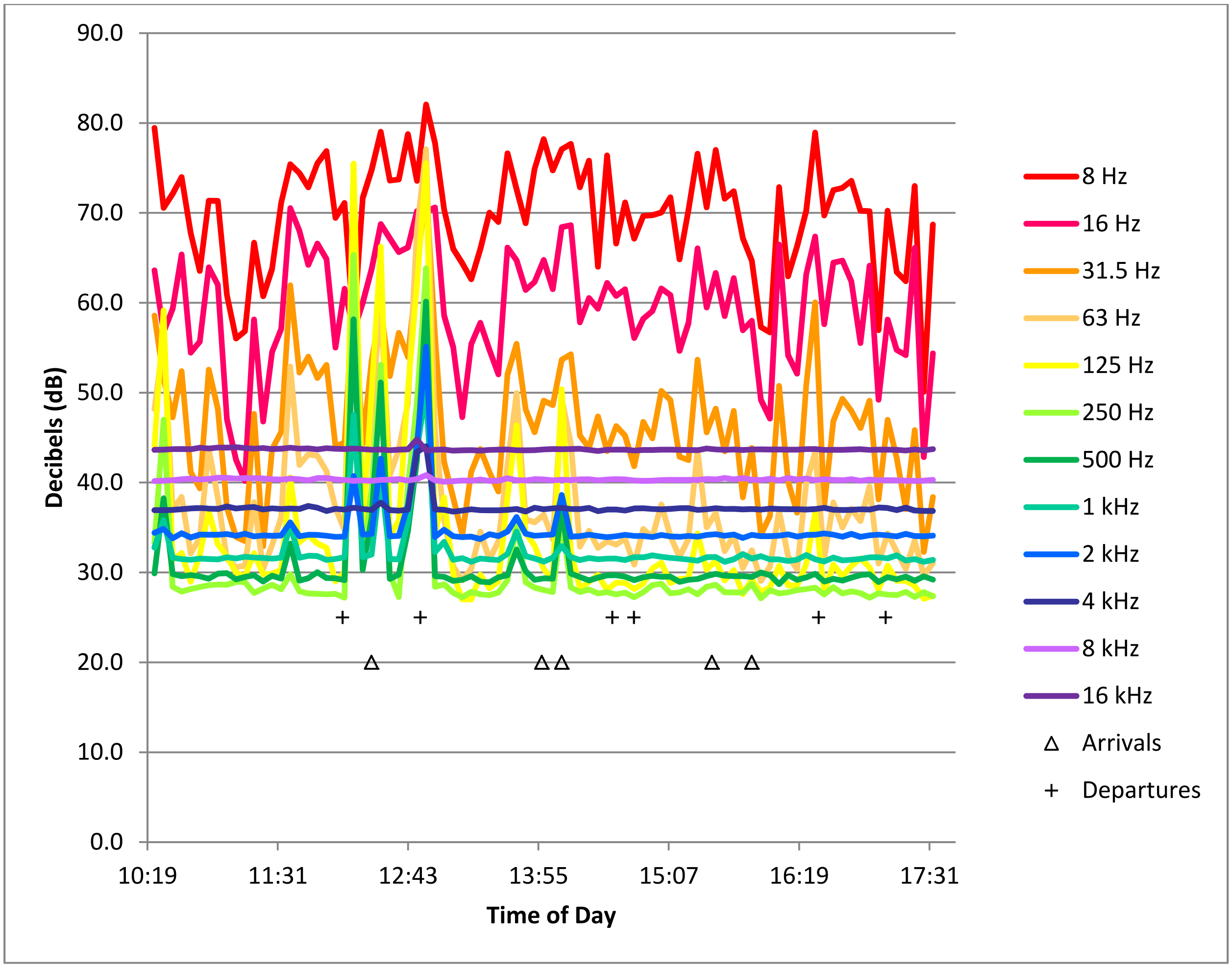


Figure 10. Unweighted Maximum Sound Levels (LZ_{Fmax}) for Octave Bands within 5-minute Sample Periods at Ritidian Pt #1 on 15 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

The data in Table 5 support the information illustrated in Figures 9 and 10, which is the lowest octaves have the greatest range of SPLs and the higher average sound levels occur in the lowest octave bands. This pattern is true for L_{Zeq} and L_{ZFmax}.

Table 5. Summary Values of Octave Bands for 15 April 2014

		Octave Band											
		8 Hz	**16 Hz**	**31.5 Hz**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1													
L_{Zeq}	min	39.58	32.89	28.38	26.18	25.40	25.97	27.95	30.45	33.33	36.45	39.92	43.39
	max	68.61	62.66	57.83	59.04	59.22	46.92	44.03	39.02	40.07	37.59	40.15	43.68
	L_{dcp}	57.90	49.22	41.41	42.16	43.94	32.17	30.98	31.15	33.72	36.60	39.99	43.47
L_{ZFmax}	min	50.10	40.18	32.29	29.07	26.98	27.12	28.69	31.18	33.72	36.77	40.09	43.51
	max	82.05	70.59	72.99	77.07	75.54	65.33	60.13	50.38	55.10	44.03	40.83	44.78
	L_{dcp}	73.17	63.24	55.90	59.35	59.54	48.55	43.44	35.79	38.43	37.40	40.32	43.70

Values are in dB.

Night of 15-16 April 2014

Sound data were obtained from Cliff Edge and Ritidian Pt #1 during the night of 15 to 16 April. Figure 11 contains graphs of L_{Zeq} and L_{Zpeak} for each location across the sample period. The SPLs at Cliff Edge, while variable, appear to have a relative constant minimum. The lowest L_{Zeq} value at Cliff Edge that night is 56.2 dB, and the lowest L_{Zpeak} value is 71.6 dB. At Ritidian Pt #1, the same type of variability in SPL is evident, but the overall sound level seems to increase over the night, starting from the lowest L_{Zeq} value of 26.3 dB recorded in the 5-min sample at 20:09. The earliest arrival marker in Figure 11 represents two landing events one minute apart at 21:33 and 21:34.

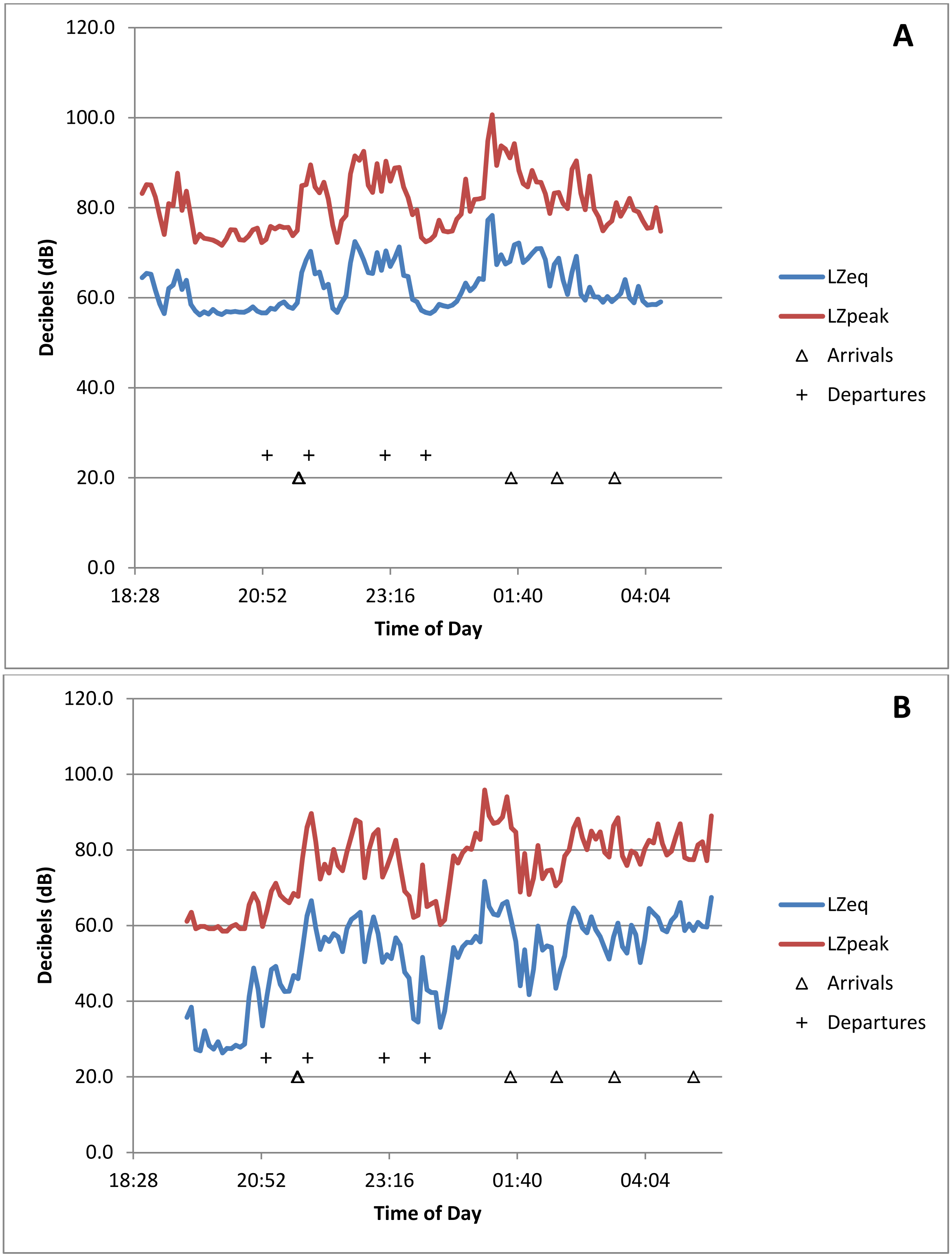


Figure 11. Unweighted Sound Levels (L_{Zeq} and L_{Zpeak}) Across the Frequency Spectrum for 5-minute Samples at Cliff Edge (A) and Ritidian Pt #1 (B) on the Night of 15-16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

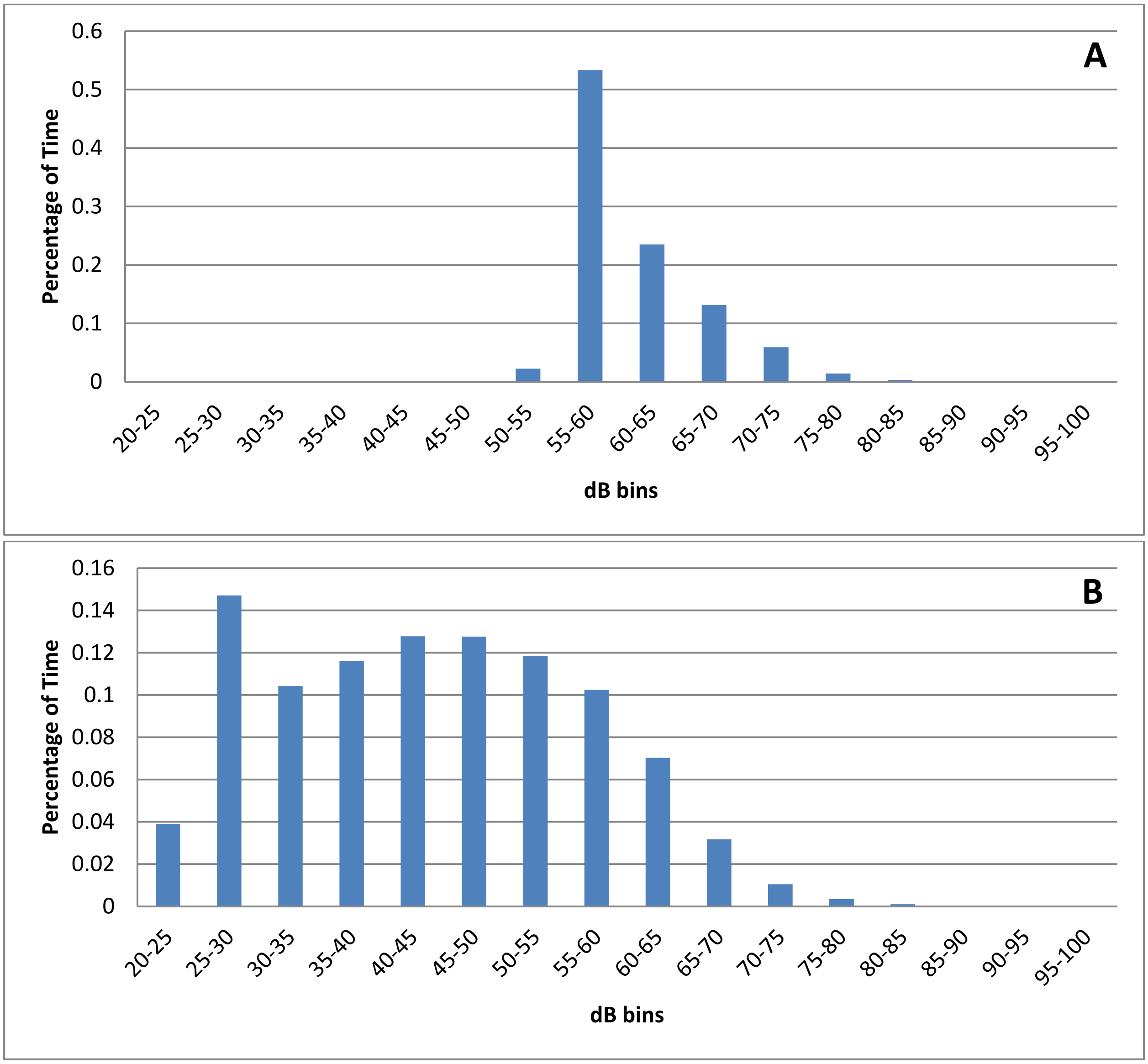


Figure 12. Histogram of the Proportion of Time Sound Levels Were Recorded at Cliff Edge (A) and Ritidian Pt #1 (B) on the Night of 15 to 16 April 2014

Data were taken at Cliff Edge from 15 April 2014, 18:31 to 16 April 2014, 04:21 and at Ritidian Pt #1 from 15 April 2014, 19:24 to 16 April 2014 05:24.

The data depicted in Figures 11 and 12 indicate that the ambient sound at the Cliff Edge site was consistently higher than the ambient sound at Ritidian Pt #1 on the night of 15 and 16 April. The proportion of time with SPLs of 60 dB or greater recorded at Cliff Edge was 44.42% and 65 dB or greater was 20.92% (Figure 13A). The proportion of time with SPLs of 60 dB or greater at Ritidian Pt #1 was 11.73% and 65 dB or greater was 4.70%. The two samples overlap for 8 hours and 57 min, so these results reflects much of the same period of time.

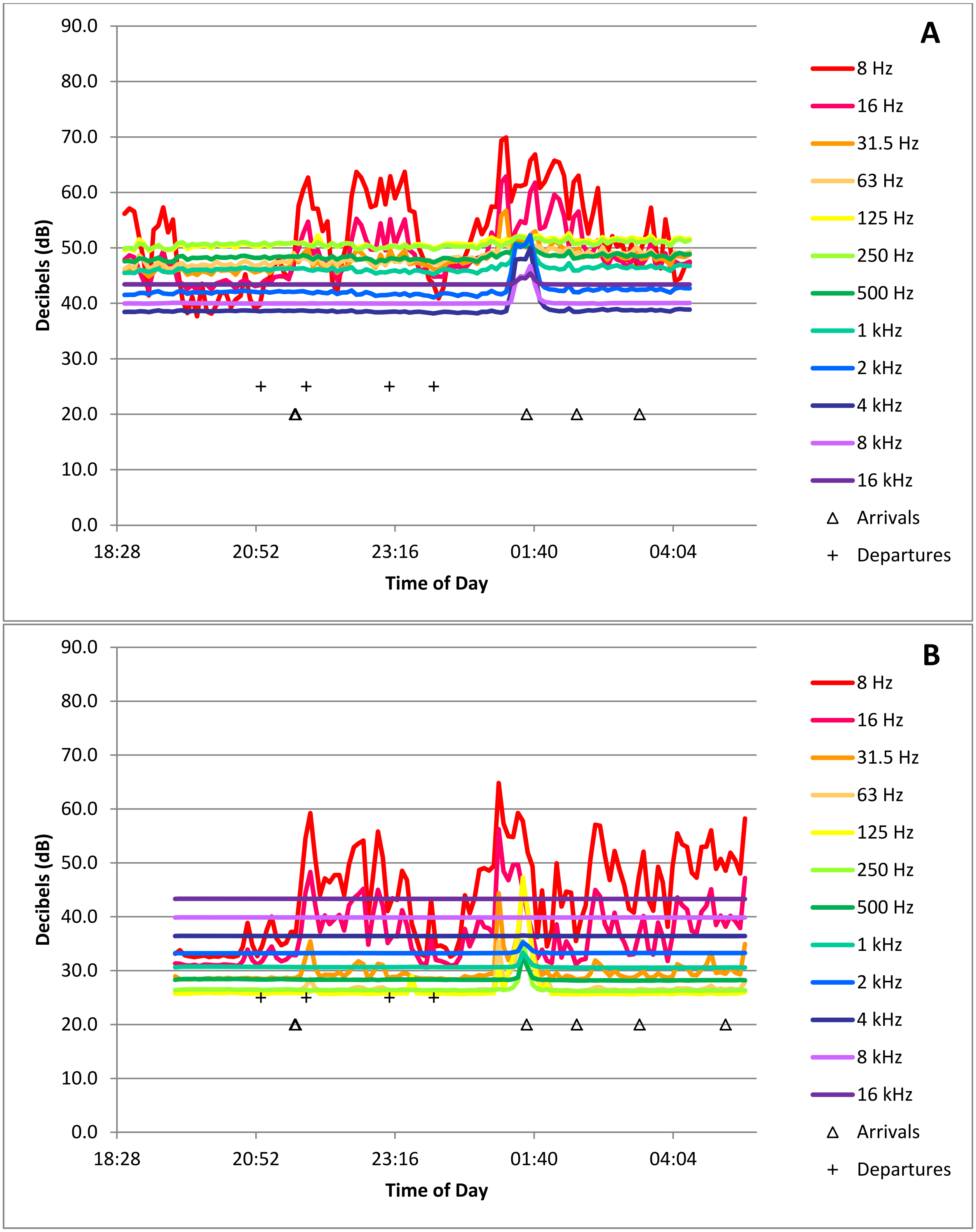


Figure 13. Unweighted Sound Levels, L_{Zeq}, for Octave Bands Integrated Across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 15 to 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

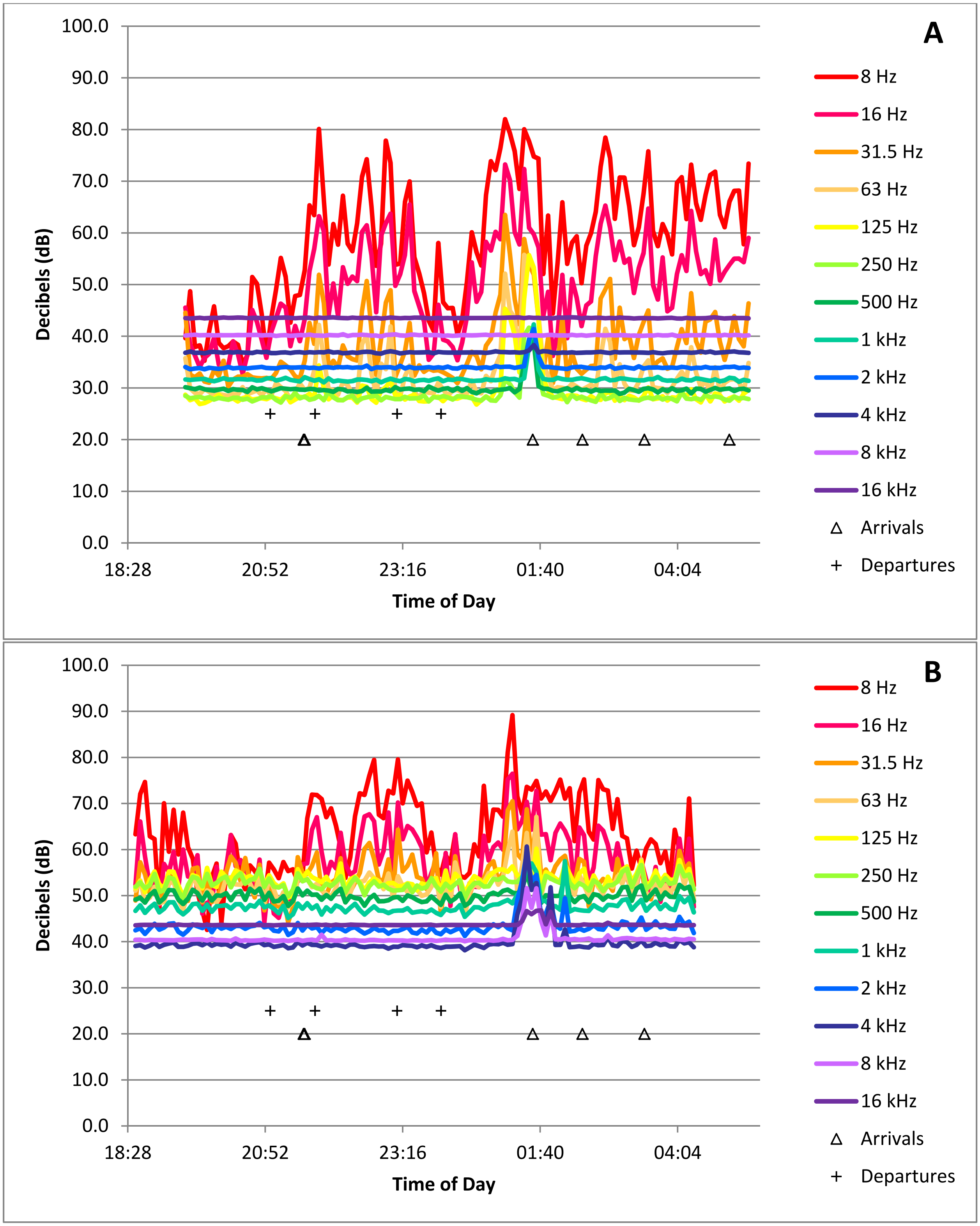


Figure 14. Unweighted Maximum Sound Levels, LZFmax, for Octave Bands Integrated Across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on the Night of 15 to 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

The breakdown of the SPLs into octave bands in Figures 13 and 14 illustrate that, like the daytime data for 15 April, much of the contribution to ambient sound comes from the lower frequencies. There is more variability in the high frequencies than during the daytime data for 15 April, and the high frequencies contribute more to the period of broadband sound that occurs between 01:21 and 01:36. The increase in levels at that time appears related to an aircraft arrival at 01:33. The broadband sound peak is visible in the data for both sites (Figures 13 and 14). A smaller and less broadband elevation in sound levels appears to correlate with two aircraft arrivals at 21:33 and a departure at 21:45; other aircraft events during the recording period do not appear to explain changes in SPLs.

The relationships between the octave bands are different between Cliff Edge and Ritidian Pt #1. The difference is clearly seen on the graphs in Figure 14. Similar to what was observed for the 15 April, the summary data in Table 6 show the lowest frequencies, up to the 63 Hz octave band, are most variable and contribute the most to the overall sound level at both sites (see also Figure 14). The SPLs of the three highest octave bands are very similar between the sites. The general SPL of the octave bands between 125 Hz and 2 kHz are greater at Cliff Edge than Ritidian Pt #1. The persistent difference in the SPLs of middle frequency octave bands suggests something systematic in the environment instead of something ephemeral.

Table 6. Summary Values of Octave Bands for the Night of 15 to 16 April 2014

		Octave Band											
		8 Hz	**16 Hz**	**31.5 Hz**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1													
L_{Zeq}	min	32.51	30.82	28.34	26.19	25.59	26.18	28.12	30.53	33.19	36.39	39.83	43.27
	max	64.81	56.25	46.37	46.21	47.31	35.57	32.79	33.31	35.24	36.52	39.90	43.33
	L_{dcp}	50.92	41.33	32.23	29.93	30.06	26.73	28.39	30.68	33.29	36.41	39.86	43.30
L_{ZFmax}	min	34.62	32.71	30.23	27.73	26.79	27.17	28.83	31.08	33.62	36.63	39.96	43.41
	max	82.00	73.24	63.46	55.75	55.69	41.65	39.42	42.27	41.40	38.30	40.36	43.66
	L_{dcp}	70.03	58.94	46.56	40.49	38.31	29.85	30.25	32.10	34.21	36.89	40.19	43.53
Cliff Edge													
L_{Zeq}	min	37.65	42.28	44.81	46.22	49.46	49.67	47.34	45.23	41.05	38.17	39.93	43.37
	max	69.89	62.91	56.70	51.59	52.64	51.98	50.76	51.29	52.24	49.93	46.73	45.39
	L_{dcp}	58.48	51.85	48.40	48.26	50.90	50.71	48.40	46.45	43.06	39.88	40.36	43.45
L_{ZFmax}	min	42.56	44.19	44.22	45.73	49.56	49.39	47.74	45.16	41.24	38.16	40.11	43.45
	max	89.18	76.44	70.47	67.09	60.19	56.63	54.89	57.47	59.35	60.64	51.60	46.81
	L_{dcp}	72.16	63.07	57.55	54.22	53.94	52.95	50.17	48.50	45.34	43.65	41.52	43.80

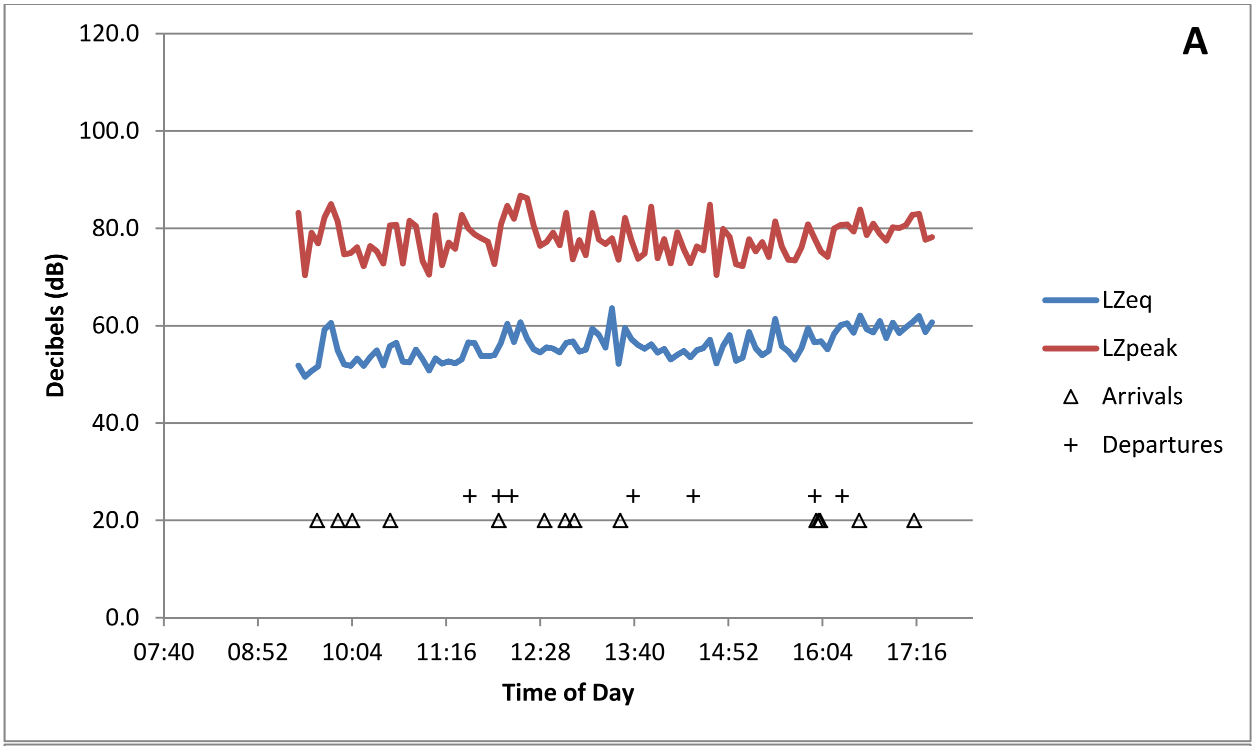
Values are in dB.

16 April 2014

Sound data were obtained from Ritidian Pt #1 and Ritidian Pt #2 on 16 April. Figure 15 contains graphs of L_{Zeq} and L_{Zpeak} for each location across the sample period. The data for both locations are more tightly bounded than the data from the night of 15 to 16 April. Overall, the more inland site of Ritidian Pt #2 has lower ambient SPLs, an apparent difference of as much as 20 dB, than Ritidian Pt #1. The histograms from the distribution tables (Figure 16) suggest that, over time, Ritidian Pt #2 was a quieter site on 16 April than Ritidian Pt #1. On the service road, SPLs were recorded at 60 dB or greater 10.76% of the time and 65 dB or greater 2.98% of the time, while at Ritidian Pt #1, 48.40% of SPLs were 60 dB or greater and 35.13% of the SPLs were 65 dB or greater. The histogram for Ritidian Pt #2 (Figure 16A) shows a tight distribution of SPLs. The distribution table for Ritidian Pt #1 (Figure 16B) is more normally distributed, as was seen for the same location in the data taken during the day on 15 April (see Figure 8).

Figures 17 and 18 show fundamental differences between Ritidian Pt #1 and Ritidian Pt #2 in the composition of ambient sound. The SPLs of the lower frequency octave bands are greater at Ritidian Pt #1 than Ritidian Pt #2. Higher frequencies show a pattern that is similar to the comparison between Cliff Edge and Ritidian Pt from the night of 15 and 16 April. The SPLs of the three highest octave bands are very similar between Ritidian Pt #1 and Ritidian Pt #2 (Table 7). The octave bands between 250 Hz and 2 kHz have greater SPLs at Ritidian Pt #2 than Ritidian Pt #1. For example, the 250-Hz octave band average sound level for L_{Zeq} at Ritidian Pt #2 is 37.70 dB vs 29.09 dB at Ritidian Pt #1. The difference of 8.61 dB indicates that ambient sound in the 250-Hz octave band is approaching being twice as loud at Ritidian Pt #2. In general, sound at Ritidian Pt #2 appears to be more consistent in SPL across the spectrum of frequencies. Although the mid-frequency octave bands have higher overall SPLs at Ritidian Pt #2, variation is much greater in those octave bands at Ritidian Pt #1 as can be seen in the L_{ZFmax} values plotted in Figure 18B and the maximum and minimum values for L_{ZFmax} in Table 7. As was seen with Cliff Edge, the persistent difference in the SPLs of middle-frequency octave bands suggests something systematic in the environment that appears to be less detectable or missing at the Ritidian Pt #1 site.

Correlating rises in ambient sound levels with aircraft events is more difficult on 16 April because there are frequent changes in sound level at various frequencies. Ritidian Pt #1 clearly had greater dynamic range on this day than Ritidian Pt #2 (Figures 17 and 18). The arrival at 16:33 appears to be the source of an elevation of broadband sound at Ritidian Pt #2, but that event correlates to a period of lower sound level at Ritidian Pt #1. There is a cluster of aircraft activity around 12:00.



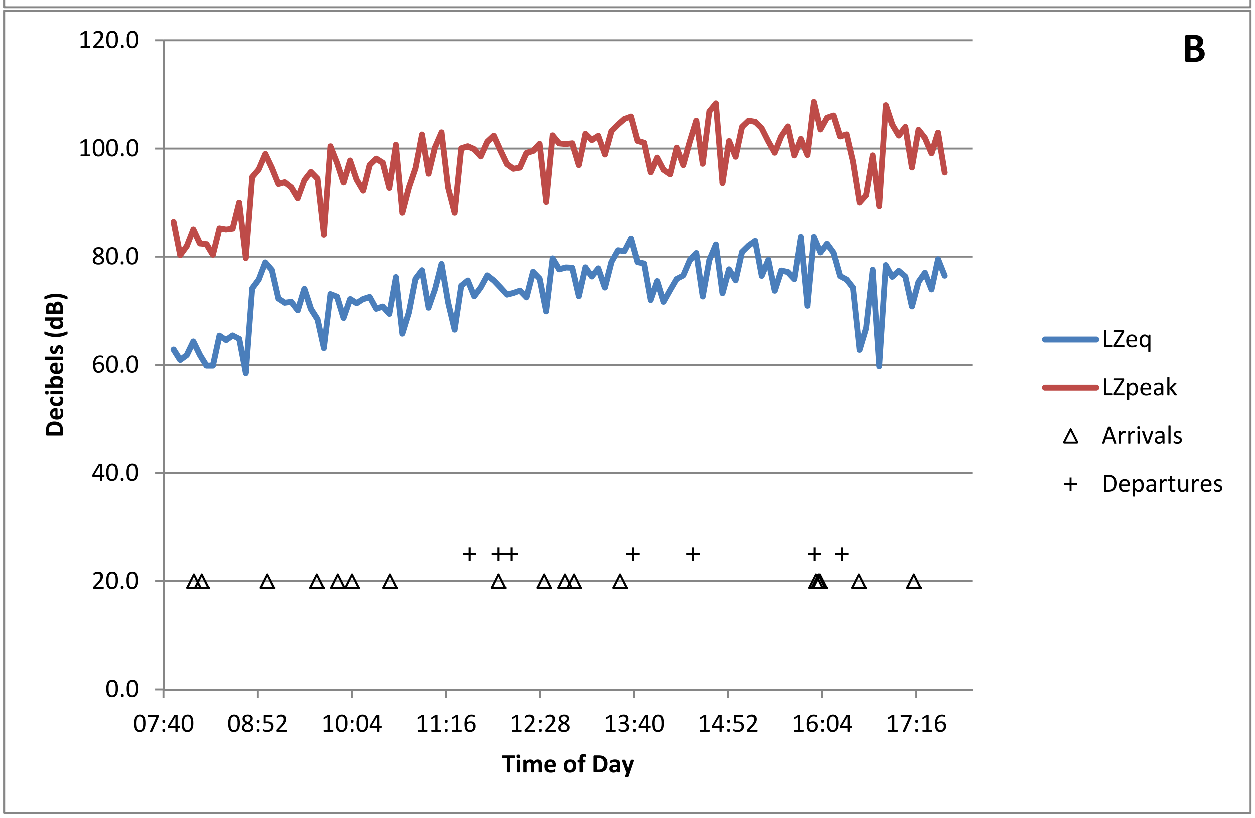
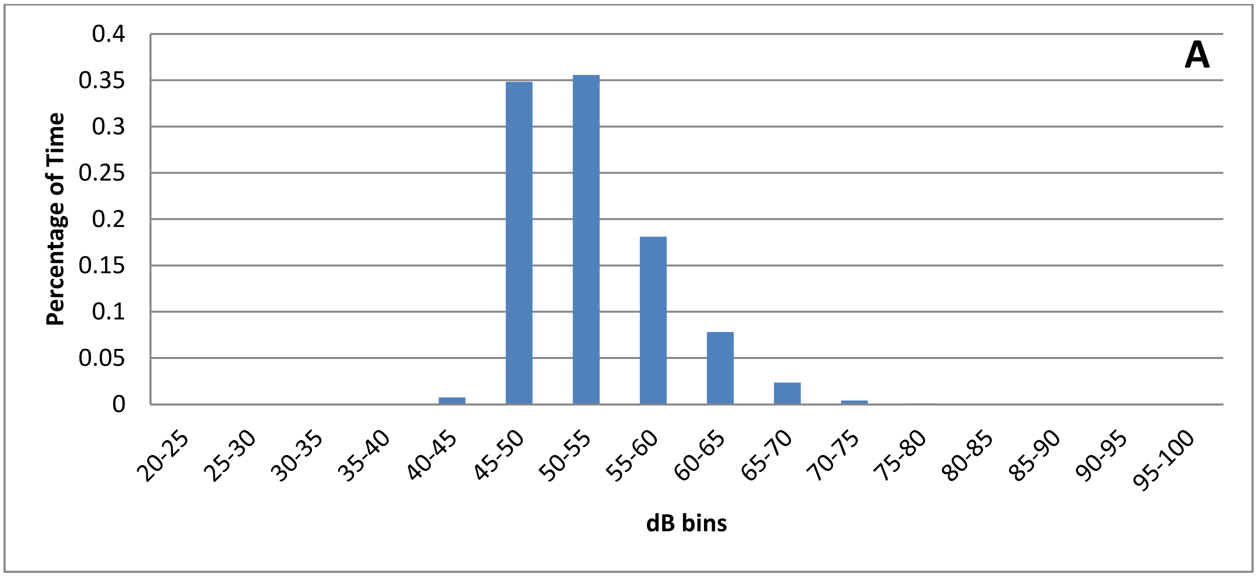


Figure 15. Unweighted Sound Levels (L_{Zeq} and L_{Zpeak}) Across the Frequency Spectrum for 5-minute Samples at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



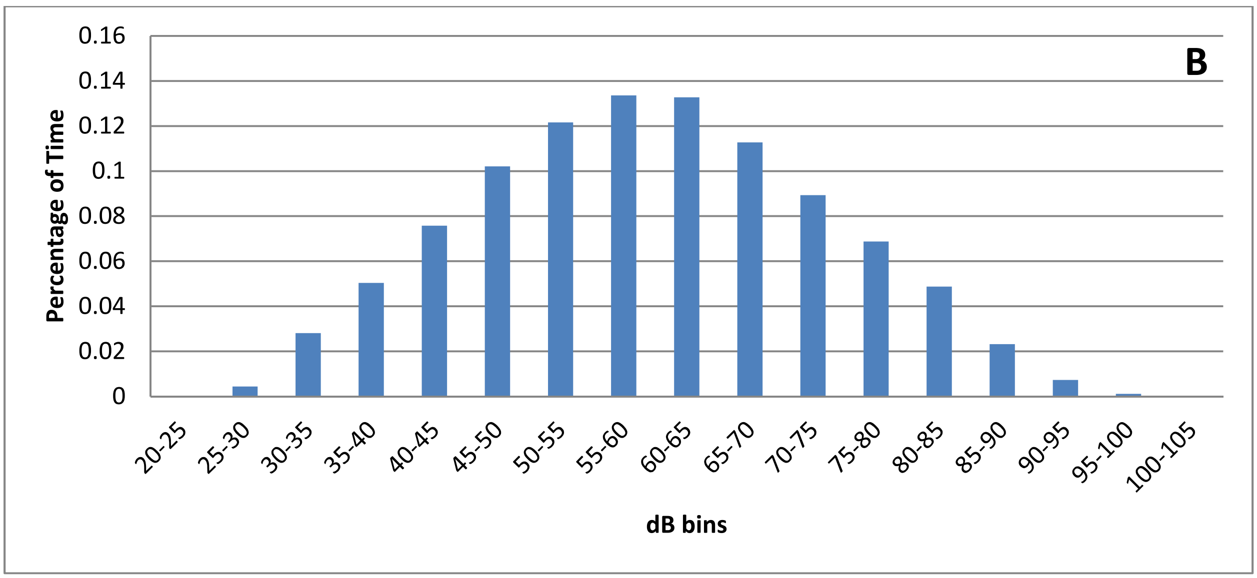


Figure 16. Histogram of the Proportion of Time Sound Levels Were Recorded at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Data were taken at Ritidian Pt #2 from 09:18 to 17:33 and at Ritidian Pt #1 from 07:48 to 17:41.

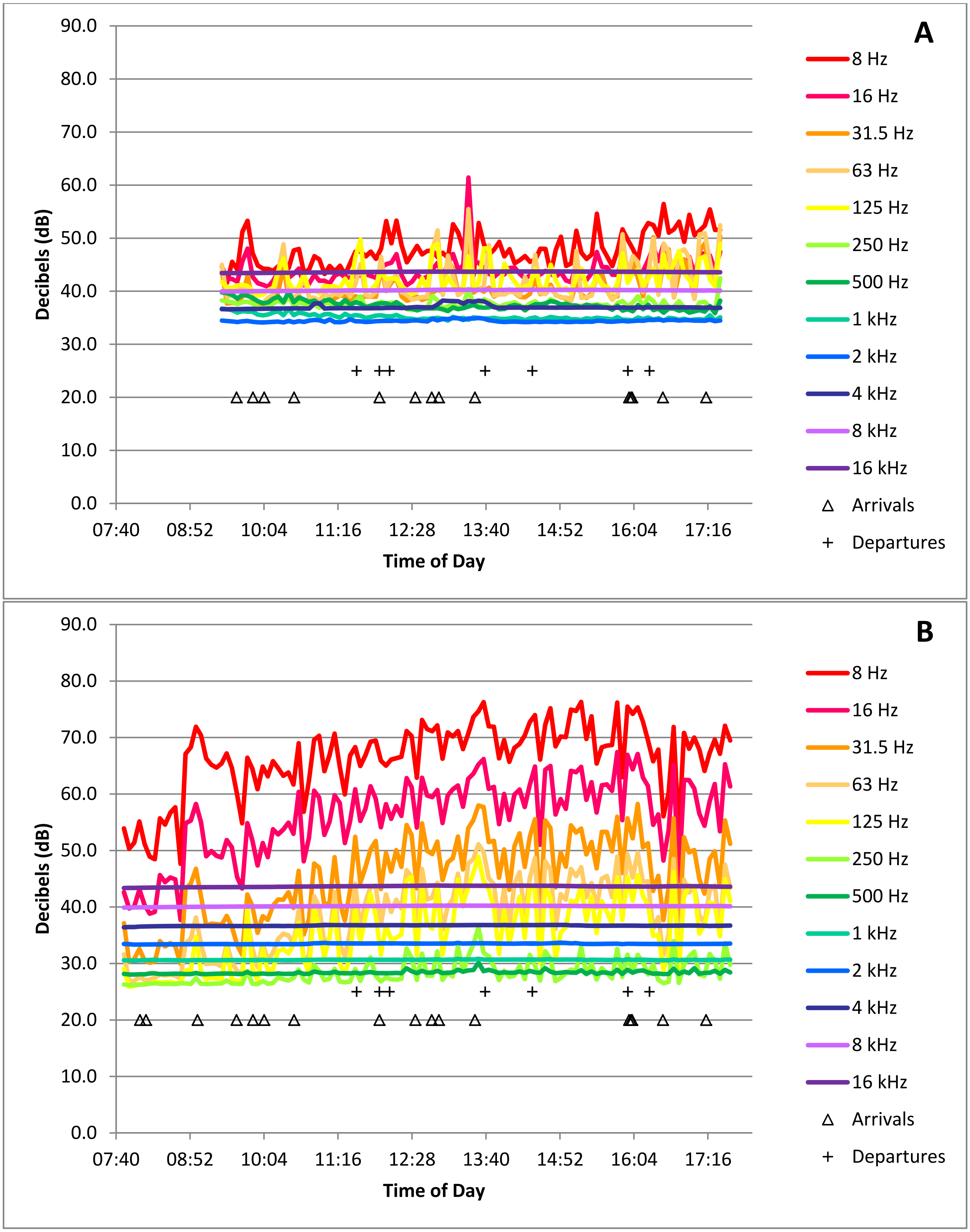


Figure 17. Unweighted Sound Levels (L_{Zeq}) for Octave Bands Integrated Across 5-minute Sample Periods at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

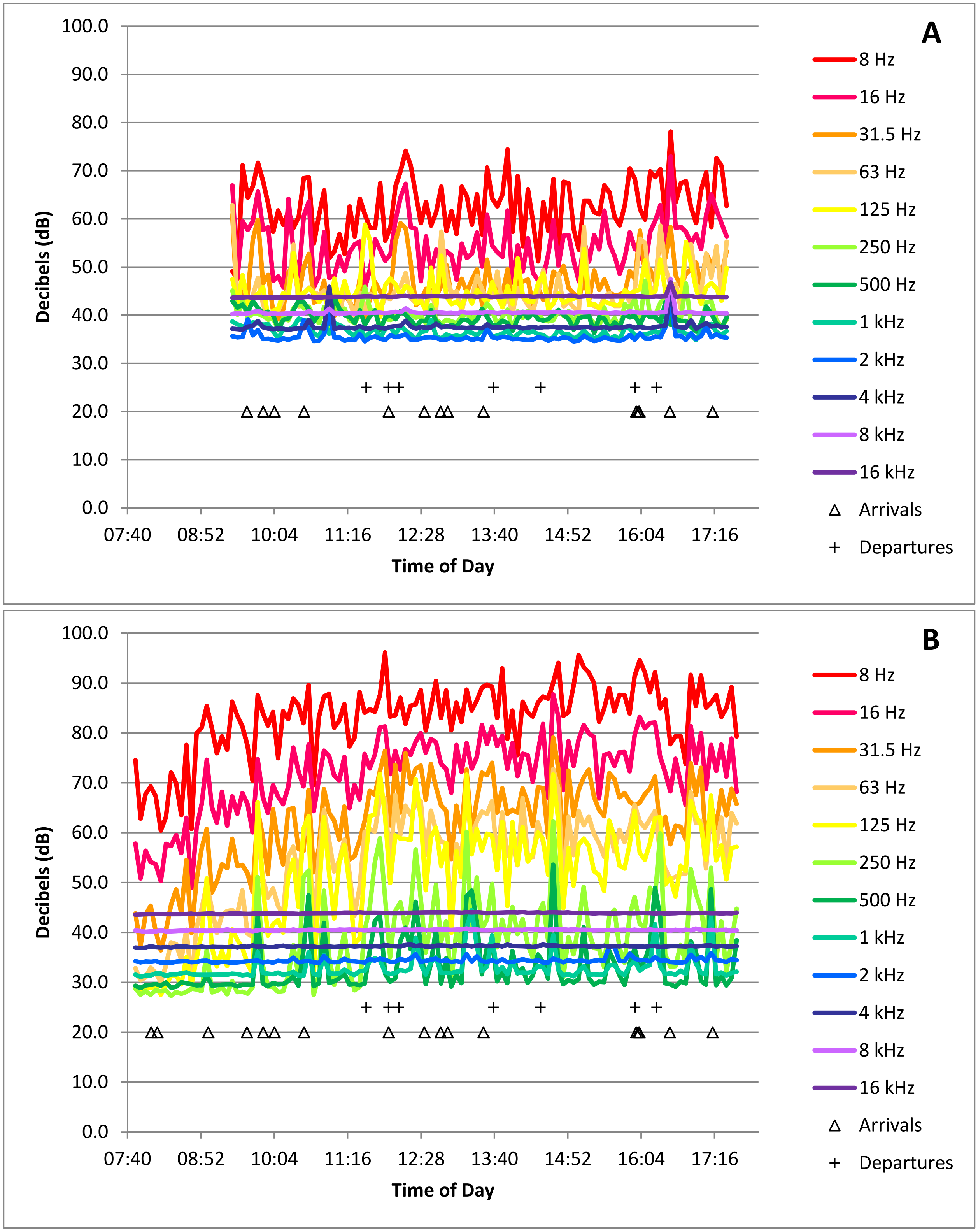


Figure 18. Unweighted Maximum Sound Levels (L_{ZFmax}) for Octave Bands Integrated Across 5-minute Sample Periods at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table 7. Summary Values of Octave Bands for 16 April 2014

		Octave Band											
		8 Hz	**16 Hz**	**31.5 Hz**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1													
L_{Zeq}	min	47.67	37.72	29.95	26.88	25.86	26.16	28.03	30.51	33.34	36.41	39.90	43.36
	max	76.30	67.40	58.24	51.10	48.92	36.33	30.15	30.82	33.66	36.85	40.24	43.79
	L_{dcp}	69.57	59.84	49.95	42.69	39.57	29.09	28.41	30.64	33.49	36.70	40.13	43.63
L_{ZFmax}	min	60.42	48.88	36.41	30.07	27.53	27.30	28.84	31.12	33.87	36.88	40.12	43.58
	max	96.11	87.70	79.03	72.75	71.75	62.27	53.56	44.44	37.23	37.58	40.76	44.08
	L_{dcp}	86.99	76.42	67.93	61.11	60.26	48.03	38.90	34.04	34.42	37.21	40.47	43.86
Ritidian Pt #2													
L_{Zeq}	min	41.60	40.83	36.68	37.78	39.20	36.00	35.87	34.42	34.10	36.59	39.96	43.40
	max	56.44	61.41	50.35	55.46	49.70	42.46	39.87	36.73	34.96	38.24	40.30	43.72
	L_{dcp}	49.20	46.07	42.24	44.51	43.23	37.70	37.49	35.17	34.41	37.02	40.16	43.61
L_{ZFmax}	min	47.60	45.73	39.01	39.09	39.61	36.77	36.32	34.82	34.56	36.99	40.25	43.62
	max	78.12	72.93	60.87	62.80	58.79	47.14	43.61	42.95	42.56	45.88	47.45	46.81
	L_{dcp}	66.55	59.08	50.47	49.44	47.20	40.70	39.78	36.89	35.77	38.00	40.71	43.89

Values are in dB.

17 April 2014

Sound data were obtained from Cliff Edge and Ritidian Pt #1 during the day on 17 April. Figure 19 contains graphs of L_{Zeq} and L_{Zpeak} for each location across the sample period. The ambient sound on this day was generally steadier and greater than at the other times measured so far for this project. This is supported by the histograms from the distribution table, which are more peaked and a few of the dB bins contain the majority of the data (Figure 20). At Cliff Edge, the SPL was 65 dB or greater for virtually the entire collection period (99.96% of the time). The L_{Zeq} was more variable at Ritidian Pt #1 than Cliff Edge, but was 60 dB or greater 74.35% of the time and was 65 dB or greater 60.93% of the time. L_{Zeq} generally stayed under 80 dB at Ritidian Pt #1, exceeding that SPL only 7.45%. At Cliff Edge, there was a general increase in the SPL over the data collection period, and L_{Zeq} levels exceeded 80 dB 32.63% of the time.

The SPLs of the octave bands are more articulated on this day than the other days recorded so far for this project, as can be seen in the graphs in Figures 21 and 22 and Table 8. The higher SPLs are measured for the lower octave bands, and the SPLs generally decrease as frequency increases. This relationship is consistent between the two sites. The L_{ZFmax} measures are quite variable throughout the day, especially at Ritidian Pt #1. The L_{ZFmax} values in some octave bands have a wider spread between maximum and minimum values at Ritidian Pt #1 than Cliff Edge (Table 8).

Despite there being a number of aircraft events throughout the data collection period on 17 April, there seems to be little correlation between most events and changes in broadband sound levels, particularly at Ritidian Pt #1. The last two arrivals appear to be correlated with broadband sound elevation at both sites (Figure 21), although the landings occur at 18:14 and 18:22, and highest peak of high frequency sound occurs at 18:37 after the aircraft have landed (Figure 22B). Some other aircraft events may cause a slight elevation in peak levels at Ritidian Pt #1, such as the arrivals between 12:38 and 14:00, but these elevations are relatively minor (Figure 22B). There is a period of elevated broadband sound between about 15:50 and 16:45, which is most evident on Figure 22. The sound level increase has no apparent correlation with aircraft events and is one of the more notable periods of variable broadband sound on 17 April.

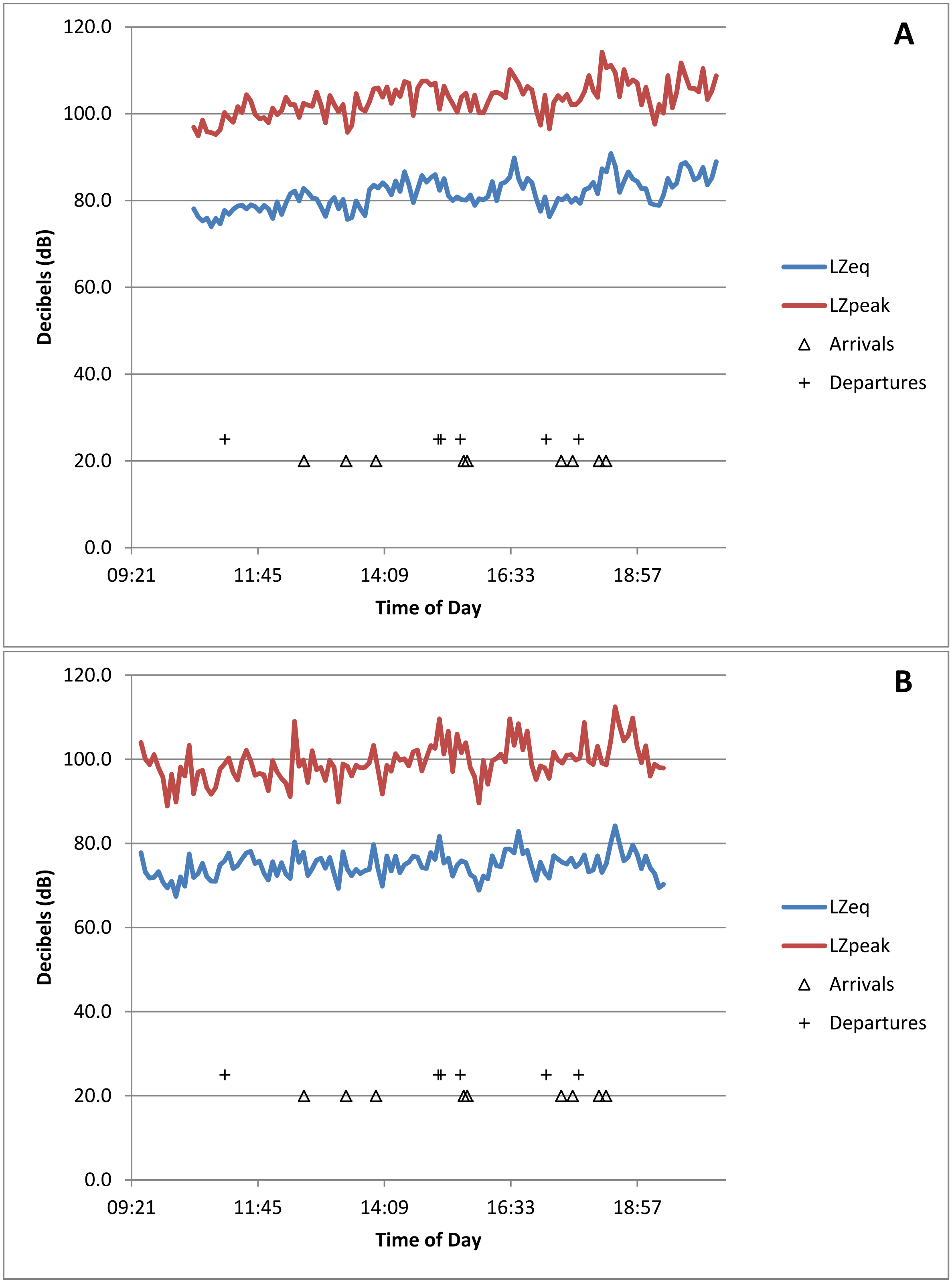
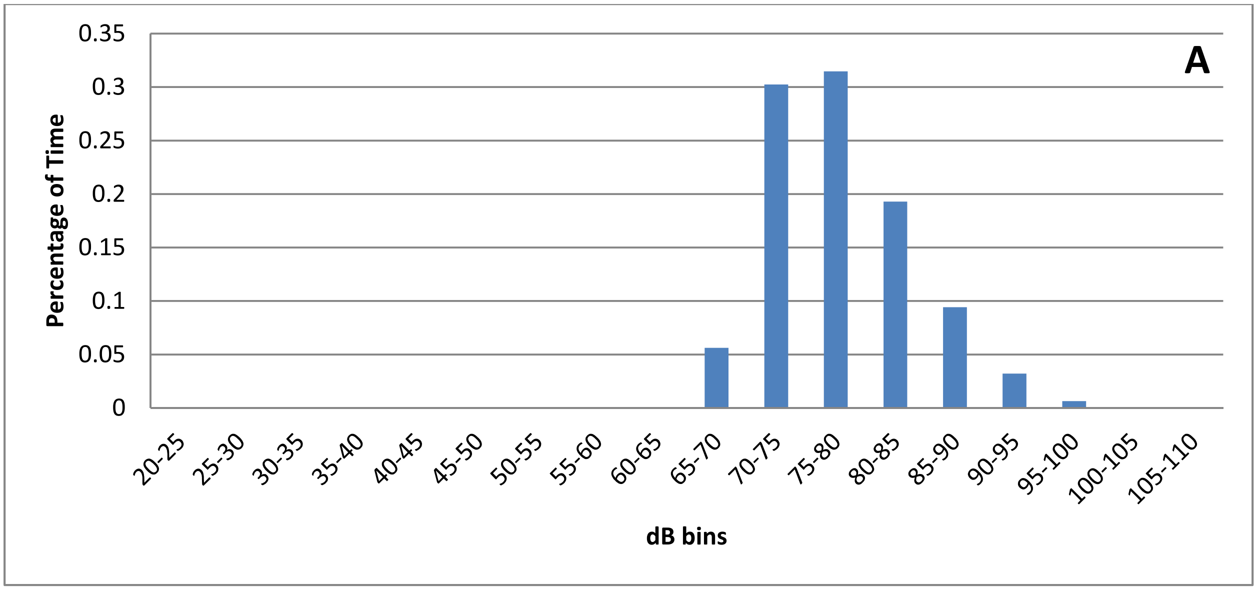


Figure 19. Unweighted Sound Levels (L_{Zeq} and L_{Zpeak}) Across the Frequency Spectrum For 5-minute Samples at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



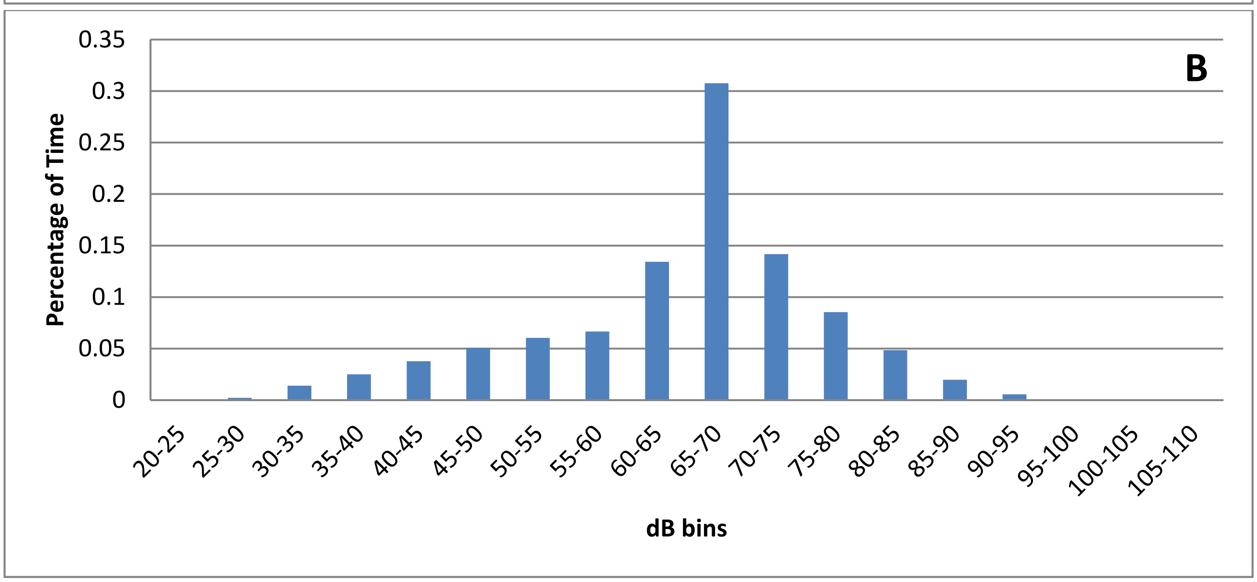


Figure 20. Histogram of the Proportion of Time Sound Levels Were Recorded at Cliff Edge (A) and at Ritidian Pt #1 (B) on 17 April 2014

Data were taken at Cliff Edge from 10:32 to 20:27 and at Ritidian Pt #1 from 9:32 to 19:27.

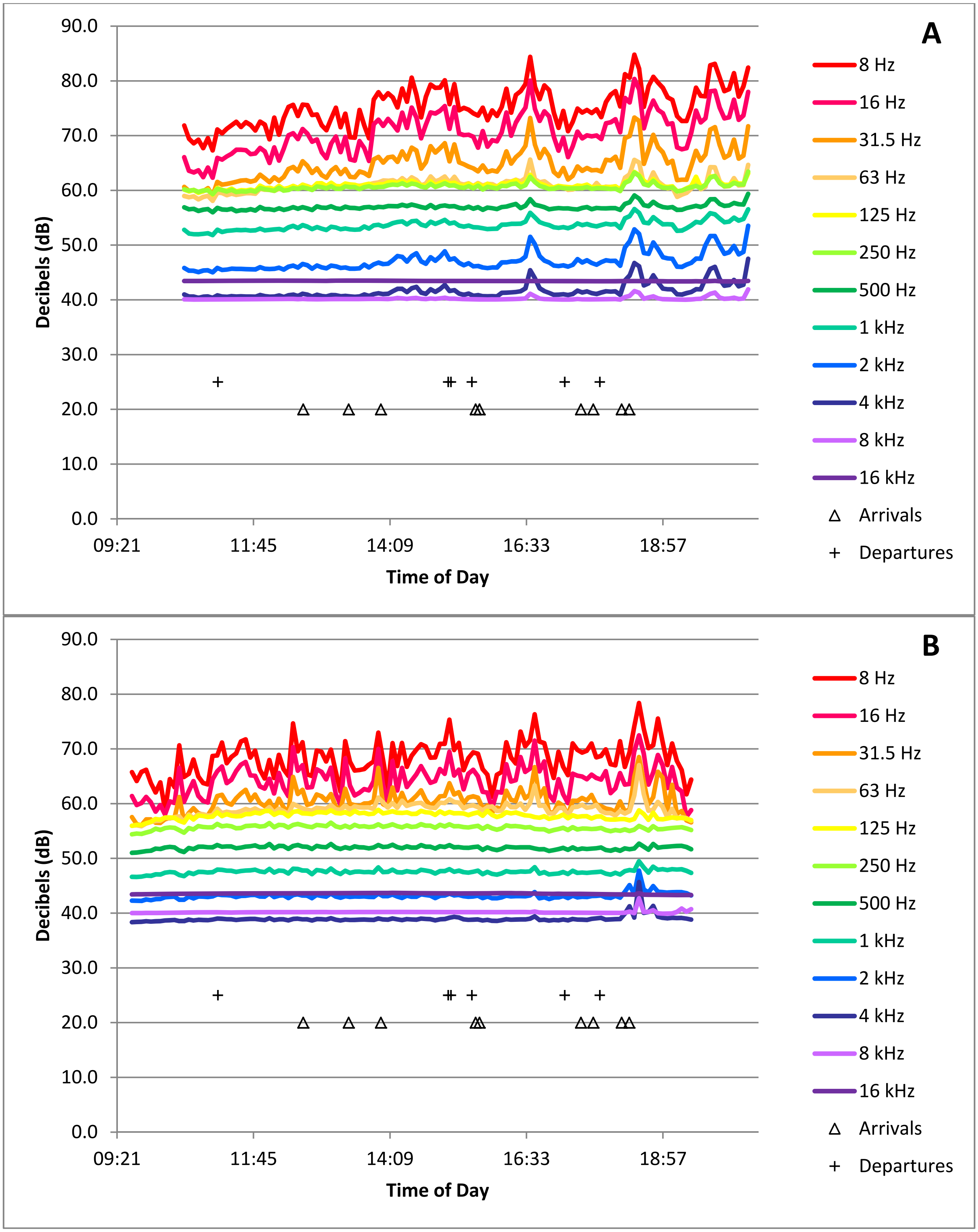
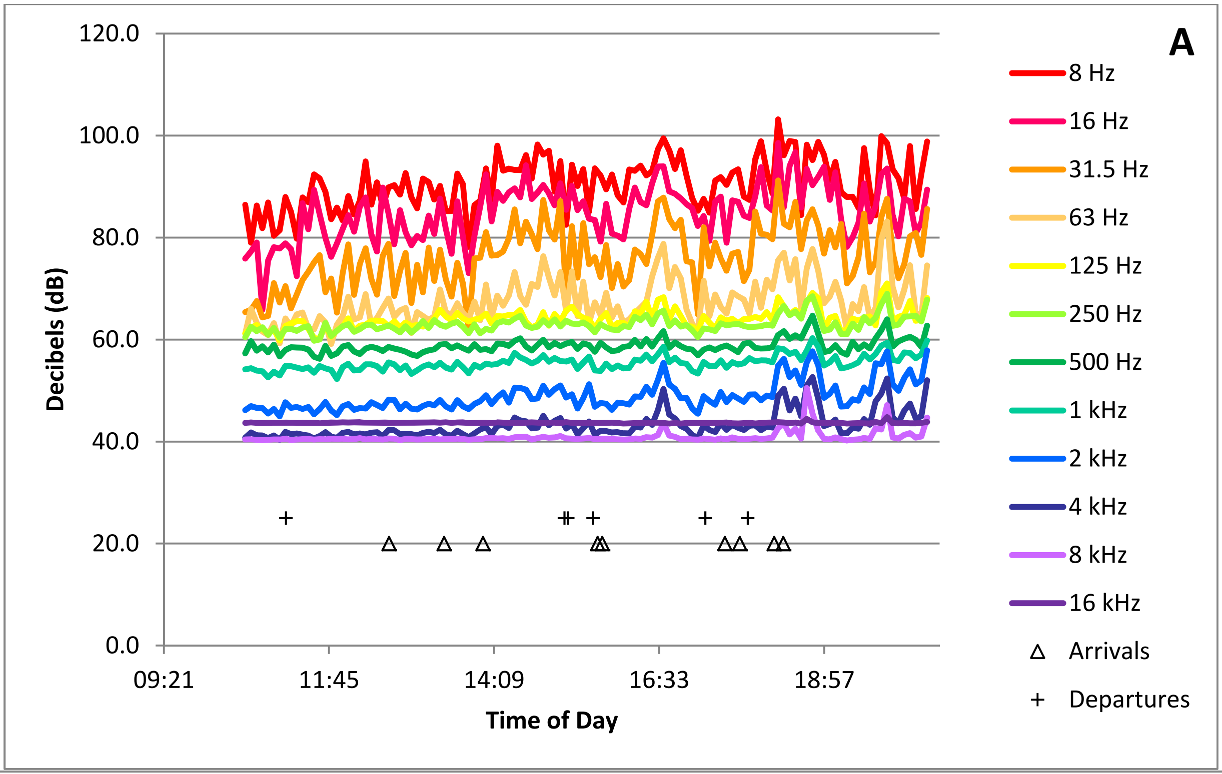


Figure 21. Unweighted Sound Levels (L_{Zeq}) for Octave Bands Integrated Across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



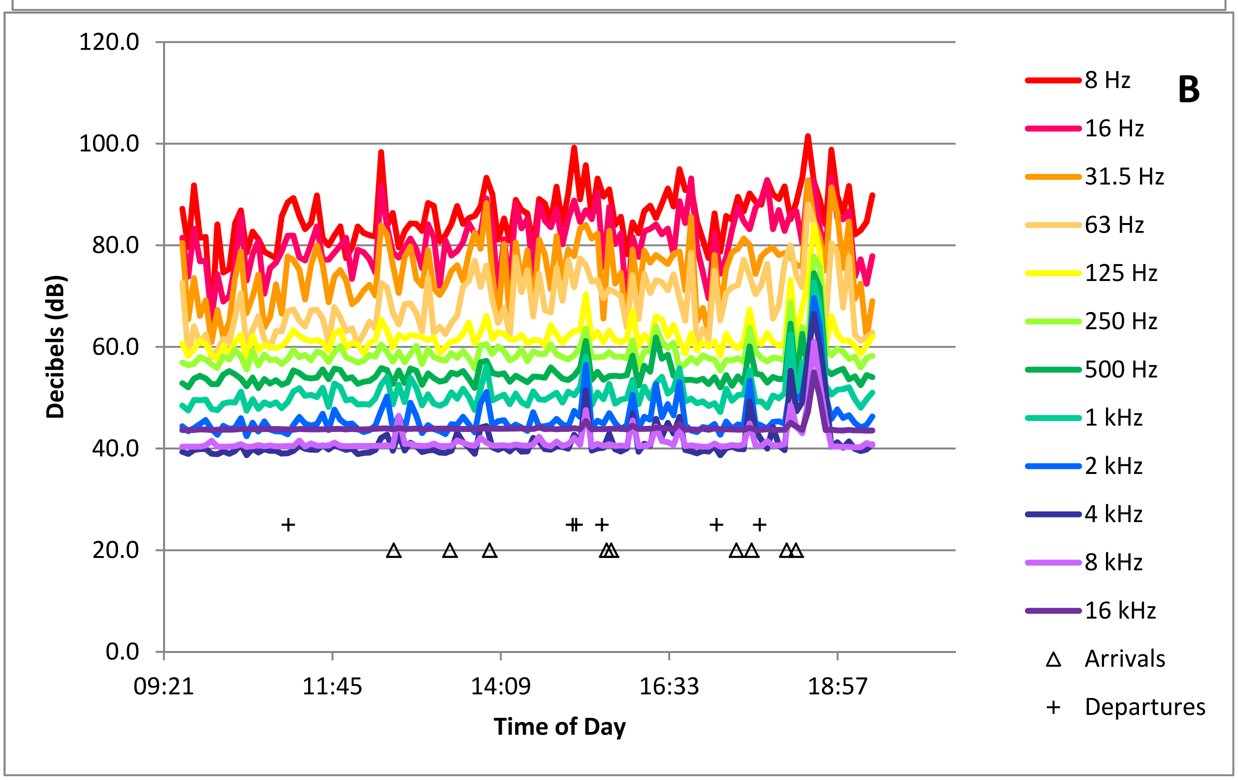


Figure 22. Unweighted Maximum Sound Levels (L_{ZFmax}) for Octave Bands Integrated Across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table 8. Summary Values of Octave Bands for 17 April 2014

		Octave Band											
		8 Hz	**16 Hz**	**31.5 Hz**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1													
L_{Zeq}	min	58.85	57.64	56.05	55.88	55.96	54.39	51.01	46.61	42.22	38.34	39.91	43.30
	max	78.39	72.46	68.50	67.02	58.85	56.58	55.69	51.60	52.69	45.79	42.71	43.68
	L_{dcp}	69.58	65.17	61.04	59.30	57.90	55.67	51.98	47.59	43.24	39.07	40.18	43.55
L_{ZFmax}	min	63.68	65.70	60.99	57.96	57.50	55.42	51.91	47.18	42.45	38.69	40.24	43.52
	max	101.49	93.36	92.81	88.10	83.99	77.76	74.50	72.73	69.59	66.46	61.01	54.97
	L_{dcp}	89.41	84.54	79.72	73.62	66.77	62.11	58.44	55.50	51.76	48.53	44.31	44.43
Cliff Edge													
L_{Zeq}	min	67.29	62.31	58.99	58.08	59.23	59.32	56.01	51.84	45.03	40.36	40.01	43.37
	max	84.79	80.35	73.31	65.61	63.37	63.26	59.10	56.58	52.89	46.72	41.60	43.52
	L_{dcp}	76.97	72.35	65.96	61.22	61.01	60.70	57.00	53.72	47.52	41.92	40.24	43.44
L_{ZFmax}	min	78.16	65.82	62.18	59.15	59.80	59.79	56.24	52.29	44.94	40.37	40.22	43.52
	max	103.17	98.53	91.20	83.15	71.00	68.97	64.70	60.28	57.68	52.64	50.49	44.78
	L_{dcp}	93.41	88.09	80.20	70.61	64.51	63.33	59.06	55.72	50.16	44.39	41.28	43.68

Values are in dB.

22 April 2014

On the last day of data acquisition, 22 April, sound data were obtained from Cliff Edge and Ritidian Pt #1 during the day. Figure 23 contains graphs of L_{Zeq} and L_{Zpeak} for each location across the sample period. Similar to what was observed at these two locations on 17 April, the ambient sound was relatively steady, in terms of L_{Zeq}, across the day. The SPL was higher at Cliff Edge (Figure 23A), but was more variable at Ritidian Pt #1 (Figure 23B). Similar to what was observed on 17 April, the L_{ZFmax} values in some octave bands, such as 63 Hz, have a wider spread between maximum and minimum values at Ritidian Pt #1 than Cliff Edge (Table 9).

The histograms from the distribution table (Figure 24) differentiate the two sites to a greater degree than the line graphs. Like 17 April, the SPL at Cliff Edge was 60 dB or greater for virtually the entire collection period (99.78% of the time) and was 65 dB or greater for 85.87% of the time. The L_{Zeq} at Ritidian Pt #1 was 60 dB or greater 55.73% of the time, and 65 dB or greater 30.76% of the sample periods. Because SPLs are recorded every 10 ms for the distribution table, the values that reflect a shorter period of time can reflect different SPLs than the measurements that are integrated over a 5-min sampling period for L_{Zeq} measurements.

The breakdown of the SPLs into octave bands shows a similar picture to the broadband L_{Zeq} data. The SPLs are relatively steady across the day, particularly at Cliff Edge (Figure 25A). There is more variability in the data at Ritidian Pt #1 (Figure 25B and Table 9) including a short-lived increase in the mid- and high-frequency octaves between about 13:30 and 15:30 for which there is no correlated increase at Cliff Edge except possibly at the lowest octaves. That may indicate some sound source that was very local to the area and did not propagate far. At both sites, the L_{Zpeak} values indicate that there was an appreciable amount of non-systematic variation in the peak sound level throughout the data collection period (Figure 26). The overall profile of ambient sound and the relationship among the octaves is generally consistent across sites as well.

Aside from some small broadband sound spikes in the late morning at Ritidian Pt #1 that do not have obvious correlating peaks at Cliff Edge, there appears to be no significant broadband sound elevation across sites on 22 April (Figure 26). The second late morning sound spike is correlated with an aircraft arrival at 12:29 (Figure 26B), but that is not apparent in the Cliff Edge data (Figure 26A). The low frequency sound elevations between 12:30 and 13:00 could be associated with the two arrival events that follow the second late morning spike (Figure 26).

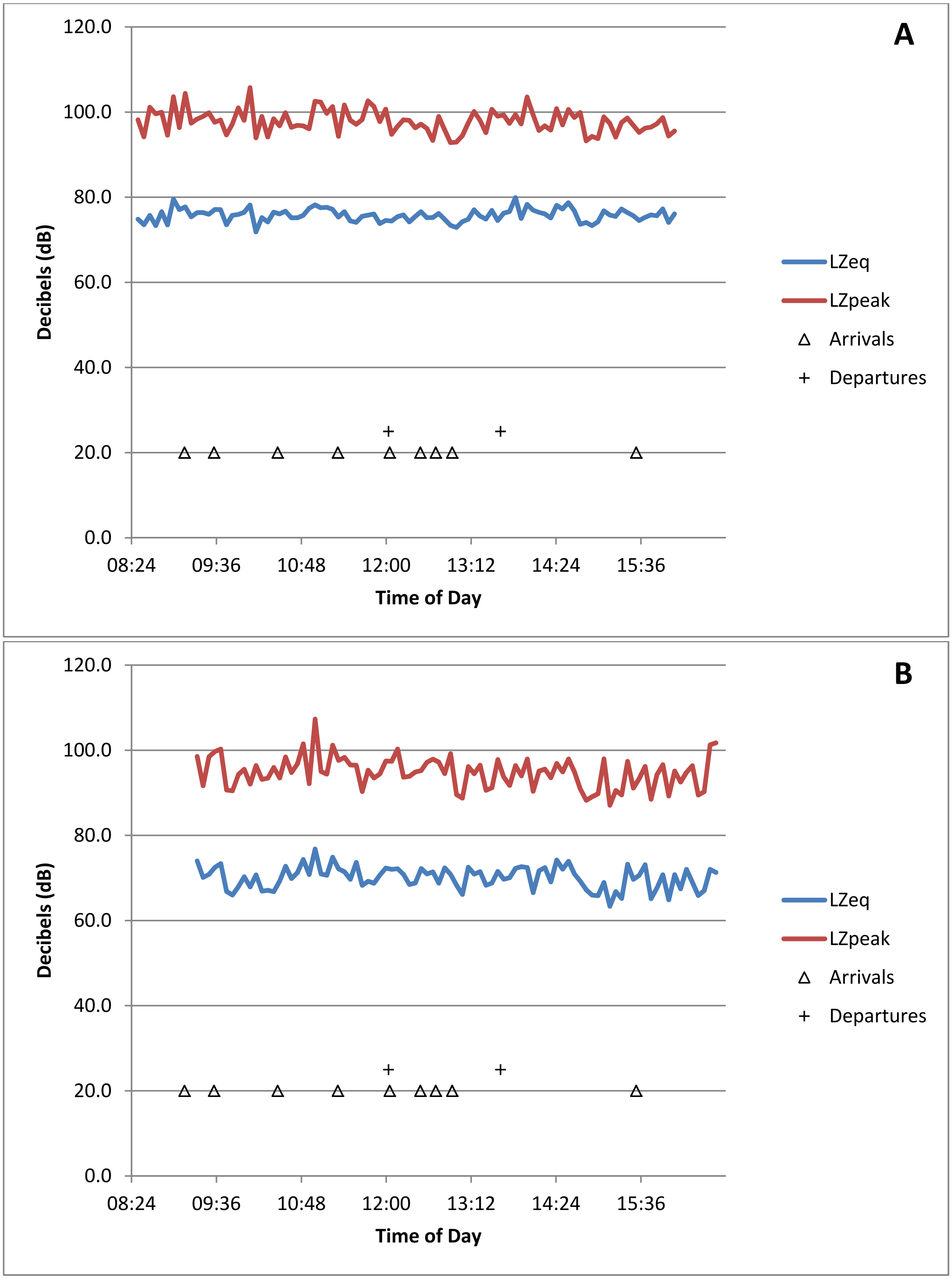


Figure 23. Unweighted Sound Levels (L_{Zeq} and L_{Zpeak}) Across the Frequency Spectrum for 5-minute Samples at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

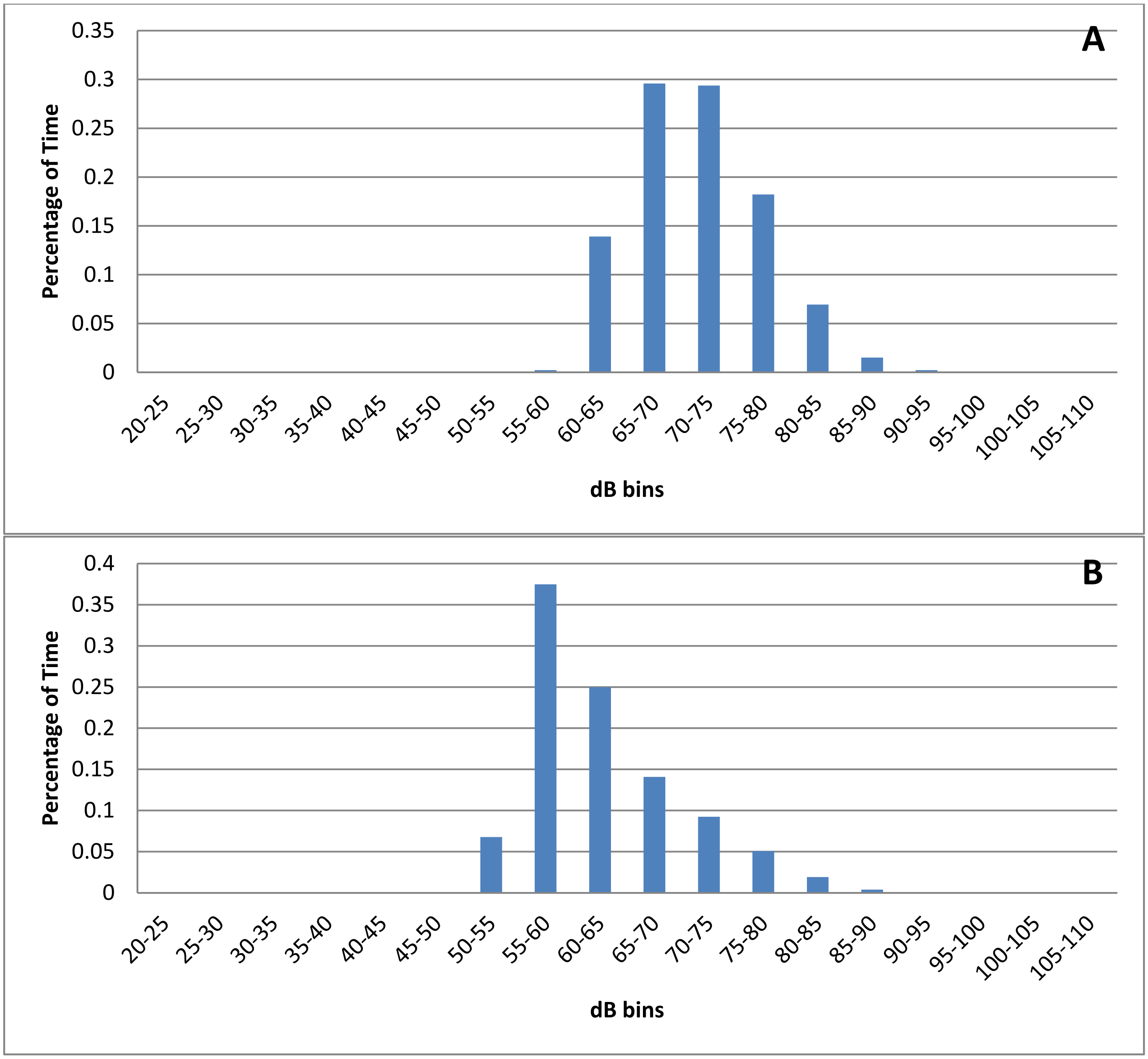


Figure 24. Histogram of the Proportion of Time Sound Levels Were Recorded at Cliff Edge (A) and Ritidian Pt #1 (B) on 22 April 2014

Data were taken at Cliff Edge from 8:29 to 16:10 and at Ritidian Pt #1 from 9:19 to 16:43.

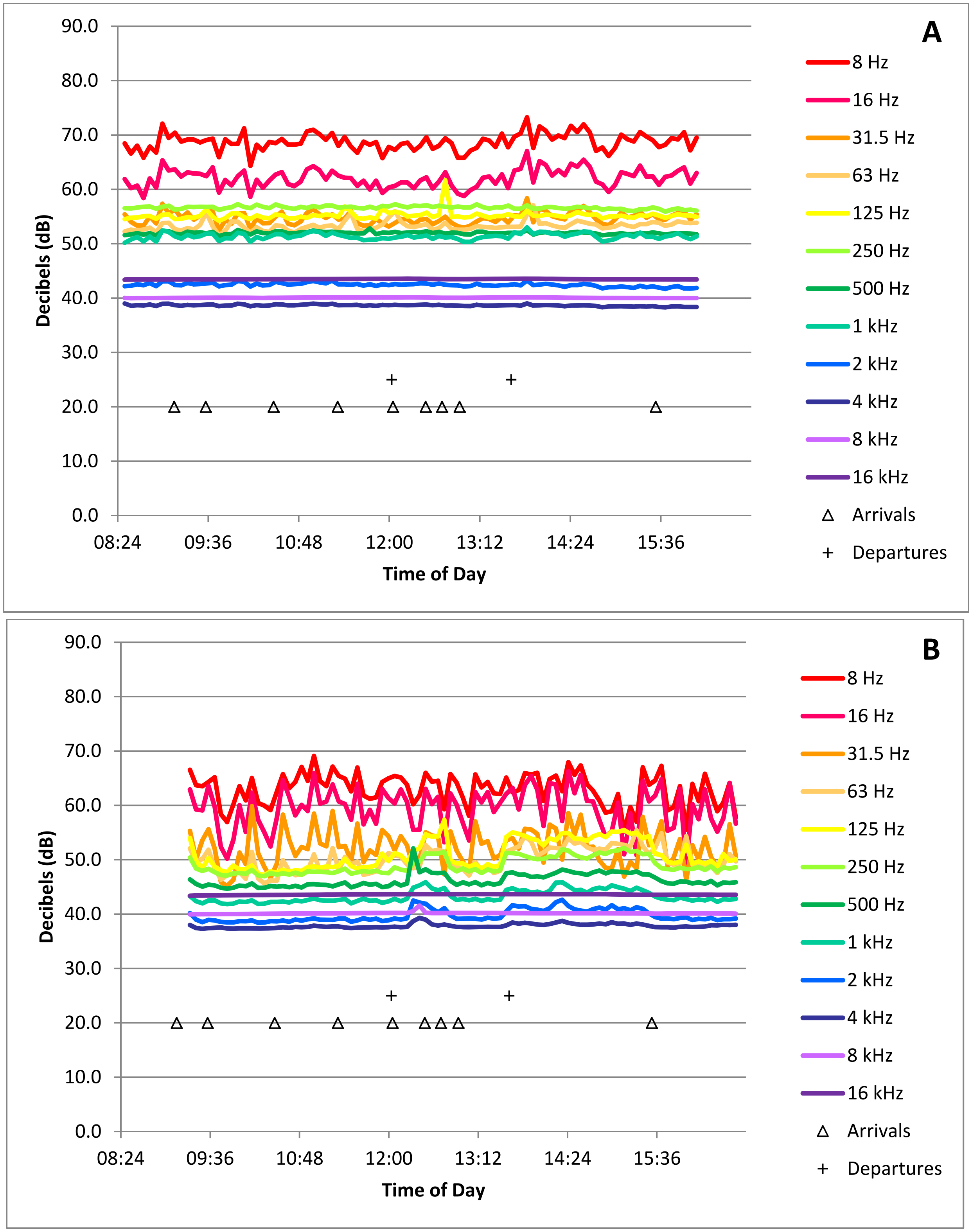


Figure 25. Unweighted Sound Levels (L_{Zeq}) for Octave Bands Integrated Across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 22 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

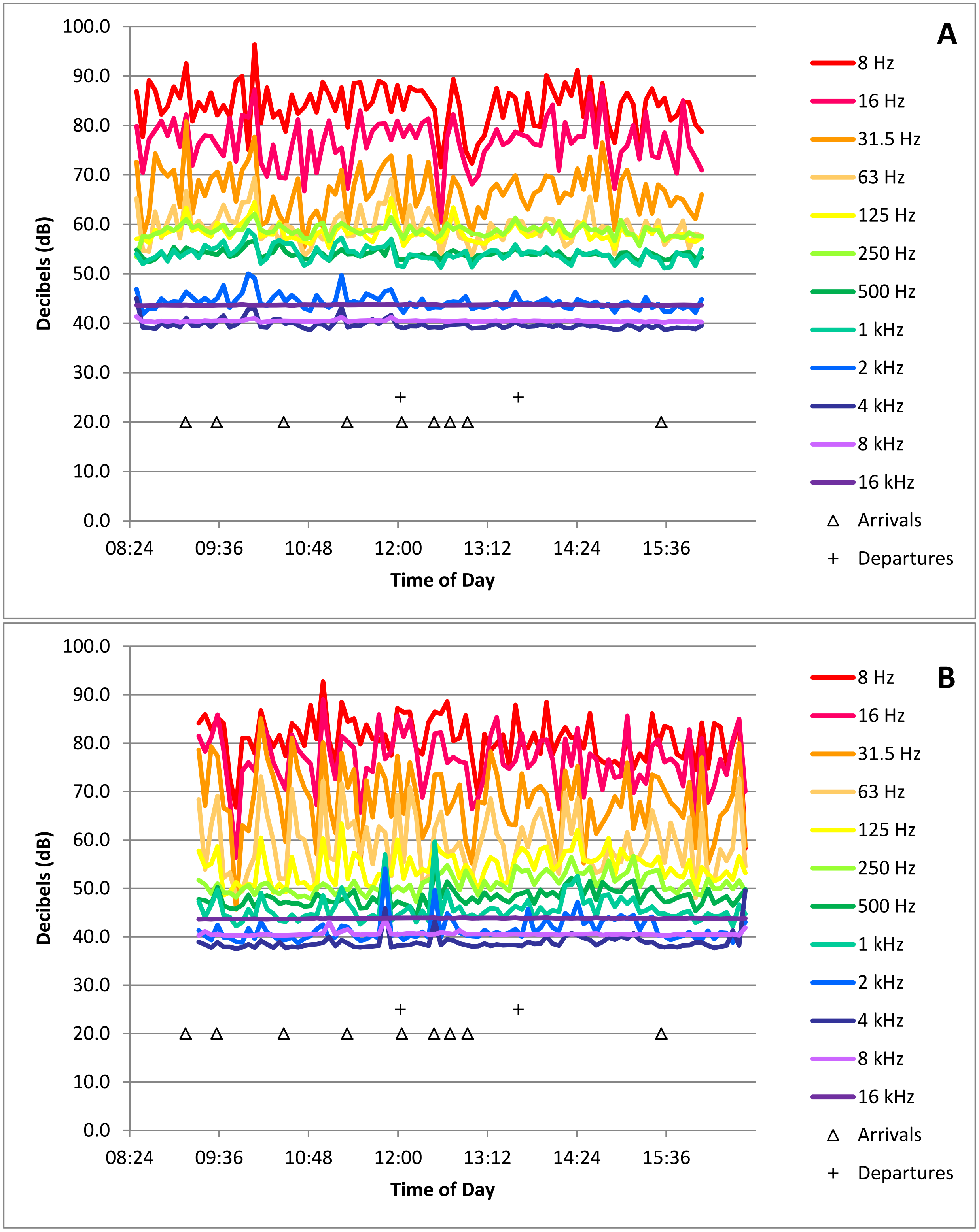


Figure 26. Unweighted Maximum Sound Levels (LZFmax) for Octave Bands Integrated Across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 22 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table 9. Summary Values of Octave Bands for 22 April 2014

		Octave Band											
		8 Hz	**16 Hz**	**31.5 Hz**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1													
L_{Zeq}	min	55.21	49.14	45.20	45.65	47.17	46.96	44.68	41.83	38.40	37.31	39.95	43.36
	max	69.10	66.31	59.86	55.45	57.37	52.19	52.08	45.87	42.65	39.30	41.55	43.67
	L_{dcp}	63.88	60.93	53.54	50.69	51.78	49.27	46.42	43.39	39.89	37.85	40.15	43.58
L_{ZFmax}	min	58.25	56.41	45.64	48.05	48.62	47.25	44.15	42.16	38.74	37.54	40.22	43.60
	max	92.69	89.04	85.09	73.06	63.34	56.65	55.28	59.65	54.02	49.56	43.73	43.93
	L_{dcp}	83.14	79.64	73.18	63.83	55.64	51.48	48.70	47.42	42.54	39.44	40.63	43.80
Cliff Edge													
L_{Zeq}	min	64.34	58.38	52.42	51.52	54.20	55.90	51.38	50.16	41.70	38.30	39.98	43.38
	max	73.27	67.05	58.36	57.04	61.66	57.27	52.82	53.00	43.25	39.01	40.13	43.56
	L_{dcp}	68.89	62.25	54.70	53.25	55.15	56.47	51.81	51.22	42.26	38.46	39.86	43.28
L_{ZFmax}	min	71.58	60.48	55.26	53.52	55.07	53.37	52.16	51.14	41.82	38.62	40.19	43.56
	max	96.35	87.85	80.78	69.41	65.19	62.09	57.03	58.80	50.01	45.02	41.34	43.83
	L_{dcp}	85.91	78.91	69.13	60.62	58.60	58.75	53.90	54.15	44.46	39.60	40.25	43.50

Values are in dB.

Discussion

Acoustical Measurements

In order for the sound measurements in this report to be applied correctly, they must be understood in context. The measurements were assessed by the SLMs using Z-weighting, which means that the SPLs were not altered or filtered to account for any increased or lost sensitivity to certain frequencies. Therefore, the SPLs do not reflect how the sound levels would be perceived by humans. Table 10 presents the differences between Z-weighting and A- and C-weighting for the individual octave bands across the spectrum that the SLMs recorded. A- and C-weighting are the filters that are appropriate to human hearing under low (A-weighting) and high (C-weighting) sound levels. The lowest two octave bands, 8 and 16 Hz, are not considered because they are not heard well by humans. Unweighted values are used as the baseline for SPLs and the adjustment that needs to be made for A- or C-weighted measurement is listed in the right two columns in Table 10.

Table 10. Adjustments Necessary to Convert Z-weighted (Unweighted) SPLs to A- and C-weighted SPLs

Octave Band Center Frequency	A-weighting dB difference	C-weighting dB difference
31.5 Hz	-39.4	-3.0
63 Hz	-26.2	-0.8
125 Hz	-16.1	-0.2
250 Hz	-8.6	0
500 Hz	-3.2	0
1 kHz	0	0
2 kHz	1.2	-0.2
4 kHz	1	-0.8
8 kHz	-1.1	-3.0
16 kHz	-6.6	-8.5

Sources: Harris 1998; PCB Piezotronics, Inc. 2010.

Other species may not perceive the SPLs in the same way as humans. As an example, Figure 27 presents hearing ranges for a variety of laboratory animals from Heffner and Heffner (2007). Humans cover a wide range of frequencies, but it is clear that even the few species presented in Figure 27 have different ranges and sensitivity levels than humans. In particular, a number of species have much higher hearing ranges than humans (for example cats, dogs, and mice). Because of these differences in the way potential receivers could perceive sound levels, recording SPLs for this study as unweighted was important because it would not present information in a way that was biased to any particular receiver or even a particular acoustic context, such as low levels or high levels of ambient sound relevant for A- or C-weighting.

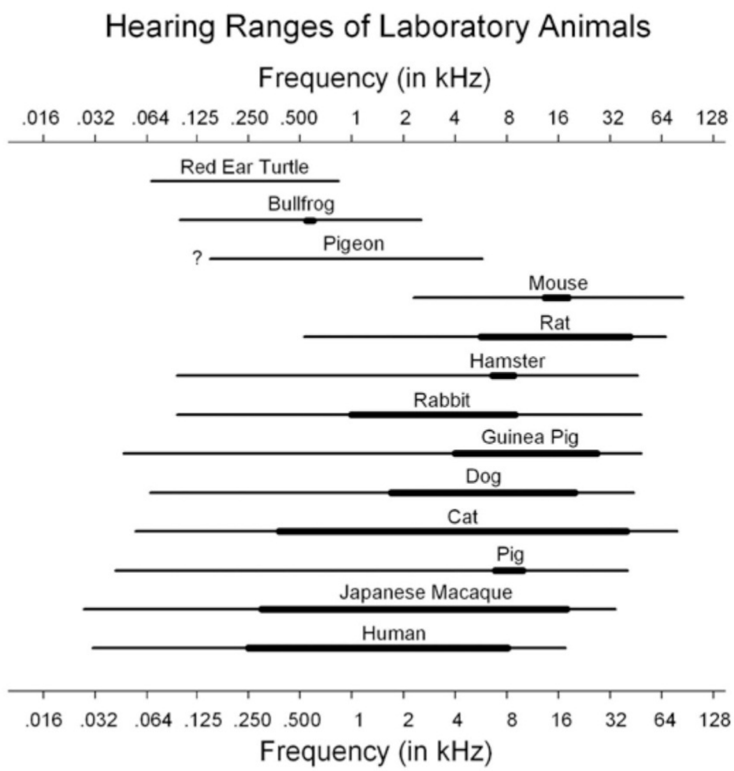


Figure 27. Hearing Ranges of Some Species of Laboratory Animals Compared with That of Humans

Notes: Thin lines indicate the range of frequencies that can be detected at 60 dB; thick lines indicate the range that can be detected at 10 dB. The low-frequency hearing of the pigeon has not been completely determined.
Source: Heffner and Heffner (2007).

It is important to understand what measurements on the dB scale mean. The dB scale is logarithmic and that is relevant to human hearing because the human ear (and many mammalian ears in general) responds logarithmically to sound intensity (Small and Gales 1998). However, it can be non-intuitive to look at a number and relate an SPL to the experience of sound heard every day. It is also challenging to look at differences between SPLs and understand how much louder one level is than another. Figure 28 provides a scale of SPLs and relates them to common sounds. Because the sounds on this scale and ones like it are given in terms of the human environment, the scales tend to reflect A-weighted SPLs. The scale gives a context that explains that, for instance, subdued conversation falls in the area around a little more than 60 dB. The minimum change in the sound level of individual events that an average human ear can detect is about 3 dB. There may not seem to be a large numerical difference between subdued conversation and city traffic, but a useful rule of thumb is that for every increase of 10 dB, to a human there is a perceptual doubling of the loudness.

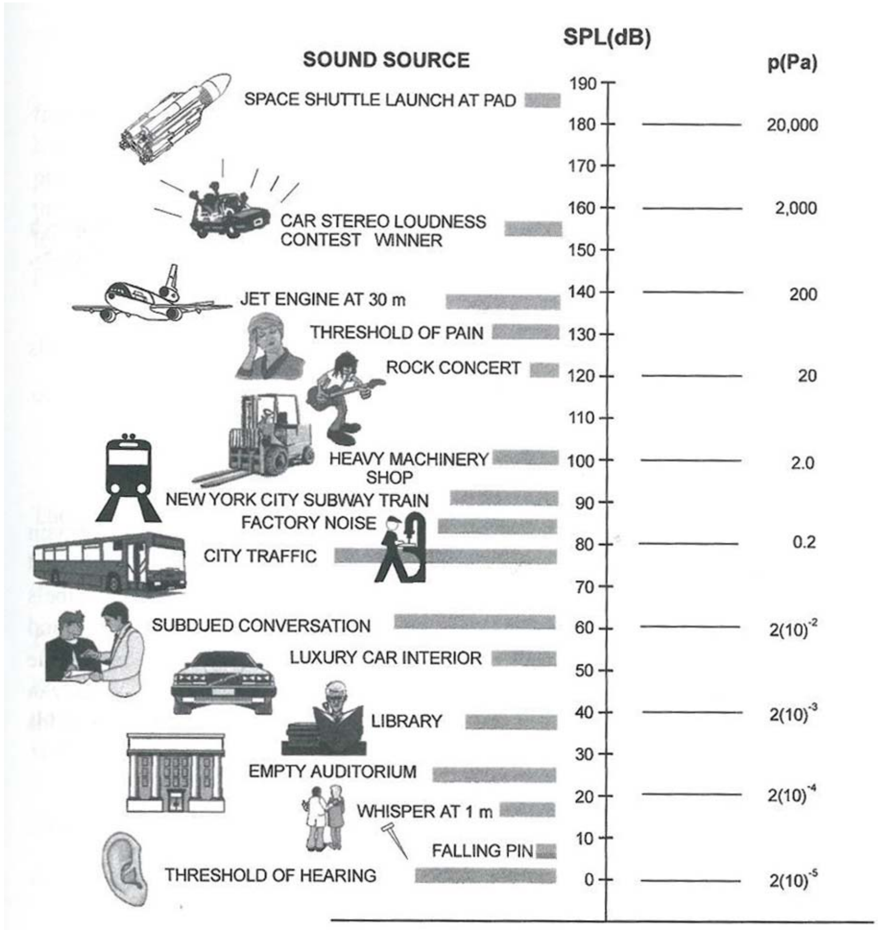


Figure 28. Examples of In-air SPLs in the Environment

Note: The pressure, in Pascals (Pa), which corresponds to the SPL scale, is on the right.

Source: Raichel (2000).

The measurement of L_{eq}, which provides a single measure across the sound spectrum, is a standard way of measuring sound. This is the measure used by industrial health and safety professionals to quantify the level of sound that varies over time. Using a single value as a threshold level typically refers to a SPL across the spectrum that can be heard, unless a specific frequency range is specified. It is important to know, though, what period of time is being referred to, because L_{eq} is an equivalent sound level measured over time. For this study, the period of time was 5 min – the period between samples. The L_{eq} will always reflect an “average” value across that time and will be different from shorter samples or measurements that take the maximum or minimum values during a period of time.

Breaking down the frequency spectrum into octave bands is useful to understand what frequencies are contributing to the ambient sound. The L_{eq} measured for any octave band will be lower than the overall L_{eq} measure across the spectrum, because the overall measurement is a combined measure of the SPLs all of the frequency bands.

Ambient Acoustic Environment at the Northeastern Portion of NWF

The L_{Zeq} measures at each site indicate that there was persistent sound at each location that was typically between 50 and 80 dB (Figures 7, 11, 15, 19, and 23). On the days that SPLs were measured for this study, the Cliff Edge site had higher levels of ambient sound than Ritidian Pt #1. On the one day that both Ritidian Pt #1 and Ritidian Pt #2 were measured, 16 April, both sites had similar L_{eq} levels (Figure 15). At all sites, the low frequencies were the greatest persistent contributors to ambient sound (Figures 9, 13, 17, 21, and 25). There are a number of natural sources of low-frequency sound. Ocean waves produce noise across the spectrum, but the majority of the energy is below 1 kHz (Bishop and Schomer 1998) with a relationship of larger waves emitting more acoustic energy in the lower frequencies (Bolin and Abom 2010). Wind is also a significant source of low-frequency sound, especially below 50 Hz (Wilson 1983). There is also low-frequency sound generated by the interaction of the sea surface with the wind, particularly during high-wind or -sea state conditions (Wilson 1980).

The wind was not particularly high on the days that data were recorded having average speeds of only 3 to 10 miles per hour (mph) (4.8 to 16 kilometers per hour [kph]) and maximum speeds of 12 to 14 mph (19.3 to 22.5 kph) in Agana (see Table 2). But the majority of the time on 16, 17, and 22 April, the wind was from the east or northeast (Figures 4, 5, and 6). The Cliff Edge site was at the northernmost point on the island and would be exposed to the wind blowing across the cliff face when from the east or against the cliff face when from the north. Ritidian Pt #1 is to the west and slightly in the lee of the island. That location would be more protected from wind noise and would receive less wave energy at the shoreline below the data recording station than the Cliff Edge site. Ritidian Pt #2, which was back from the cliff, would receive even less sound from waves than Ritidian Pt #1 and could be exposed to less wind because it is not at the edge of the cliff.

The cause of persistent mid-frequency sound at the Cliff Edge site that was not measured at Ritidian Pt #1 (Figures 13 and 25) is uncertain. Wind can generate broad-spectrum sound (Wilson 1983). Sound that is produced as wind moves through vegetation is “red” in nature, that is, with greater SPLs at frequencies below 1 kHz (Wilson and White 2010, Raspet and Webster 2015). More vegetation is closer to the Cliff Edge site than Ritidian Pt #1 and Ritidian Pt #2, which are both in clearings. The persistent mid-frequency ambient sound could be primarily from wind moving through the vegetation. Rain could also be a source of broad-spectrum sound, but little of it fell during the sampling period (see Table 2), so it could not be a major contributor to these data. Additionally, when rain was reported, between 14:30 and 19:00 on 15 April, there is not an increase in the SPLs taken at Ritidian Pt #1 during that time on that day (Figure 9). Sound from wildlife, such as birds, is not a factor in the forests of Guam because the majority of birds that previously occurred in Guam forests have been eliminated by brown treesnakes (Fritts and Rodda 1998).

No matter what the source of the ambient sound is, during the sampling period there was a persistent acoustic floor at the three sites that was measured near the edge of the cliff at NWF that can be above 65 dB (unweighted) a large percentage of the time (Table 6). Of the three sites, Cliff Edge seems to be noisier with the unweighted 5-min L_{eq} virtually never below 50 dB and above 65 dB almost 100% of the time on some days. This site is in the heart of the primary limestone forest on NWF. The weather was mild on the days that the data were taken with low wind and low precipitation (see Table 2). Guam is a location known for wind, rain, and high sea states, all of which contribute to ambient sound. The data collected during this study is likely to represent the lower end of ambient SPLs that could occur on NWF from environmental factors such as wind, surf, and rain.

Table 11. Percentages of Time below L_{Zeq} of 50 dB or above L_{Zeq} of 65 dB at All Three Sampling Sites during the Sampling Period

Location	Date	<50 dB	≥65 dB
Cliff Edge	15-16 April	0%	20.92%
	17 April	0.00006%	99.96%
	22 April	0%	85.87%
Ritidian Pt #1	15 April	39.57%	16.87%
	15-16 April	66.17%	4.70%
	16 April	26.07%	35.13%
	17 April	12.95%	60.93%
	22 April	0.002%	30.76%
Ritidian Pt #2	16 April	35.56%	2.96%

There were occasional periods of elevated broad spectrum ambient sound in the data set. The L_{Zmax} graphs were the best representations for viewing these events. They did not show the same SPLs or same spectra from event to event (also seen in Figures 14, 18, 22, and 26). These events show up during the nighttime and daytime data. AAFB is an operating Air Force Base. Some of the broad spectrum sound events correlate with the aircraft arrivals or departures. When aircraft events were measured in the data, they appeared as abrupt and transient peaks of broad spectrum sound, as shown in Figures 9 and 22. Aircraft activity does not account for all of the periods of elevated broad spectrum sound, and there are many aircraft arrivals and departures that are not clearly evidenced in the sound measurements at all. A number of factors could affect the amplitude and detectability of aircraft events including direction of approach or takeoff, type of aircraft, altitude when passing over the recording station, and wind direction. The types of aircraft arriving and departing from AAFB is not provided in this report for security reasons, but inspection of the data did not reveal that a particular model or type of aircraft was correlated with broad spectrum sound elevations in the data. The data analyzed for this report included fixed-wing and rotary-wing aircraft.

It is not clear what sources could be causing mid- and high-frequency ambient sound elevation other than the sources discussed above, such as wind and precipitation. What is highlighted by the presence of various levels of sound across the spectrum is that NWF is a complex sonic environment. There are numerous sources of sound that have been identified here and probably many more that have not. These sounds combine to create a dynamic soundscape that is challenging to characterize. It is likely that more persistent and dominant sounds would mask and reduce the detectability of transient or lower SPL sounds at the same frequency.

The sound data presented in this report should be viewed as a typical representation of coastal sound levels on Guam. Data were recorded from elevated positions near the coast. If the equipment had been positioned at the beach, one could expect low-frequency sound from ocean waves to contribute to the data to a greater degree. The elevated position, particularly at Cliff Edge, probably allowed wind to contribute to sound measurements to a greater degree than would be expected from a recording station that would be positioned at a low elevation away from the shore. As stated above, the weather and sea conditions during the period of data acquisition were mild, so the measurements here can reasonably be expected to be the low end of the ambient SPLs for the locations measured.

Conclusion

During this study, the unweighted broadband L_{eq} was generally between 60 and 80 dB at the three sites where data were taken at NWF. The Cliff Edge site typically had greater ambient sound SPLs that Ritidian Pt #1. Even with the mild environmental conditions, this study shows that broadband sound levels were above 65 dB a significant portion of the time. This finding indicates that animals and people living in this environment are regularly experiencing ambient L_{Zeq} values that, in human terms, are at the level of conversation or greater. Peak levels of sound (L_{Zpeak}) can exceed 100 dB with regularity on some days. Aircraft events at AAFB also correlate with some transient broadband elevated sound events that occur on a daily basis. The acoustic environment at the edge of NWF above the GNWR is noisy as a result of numerous sound sources that are regularly present. To be perceived or detectable in this environment, added sound sources would need to overcome a soundscape already laden with sonic energy that could mask other sounds.

The three sites where data were recorded for this study were intended to be representative locations for ambient sound near the edge of the cliff at NWF on AAFB. The two sites that were used primarily, Cliff Edge and Ritidian Pt #1, generated data that met that objective. Due to the different positions of the sites, they reflect some differences in their exposure to environmental factors that would elevate or reduce environmental sounds such as wind, surf, and noise from vegetation movement. The mild weather conditions that occurred during data acquisition resulted in data that are representative of northern coastal Guam, but probably represent the low end of SPLs for unweighted ambient sound.

This study should be taken as an initial representation of the soundscape at the edge of NWF. To have a more complete sense of the acoustic environment across the landscape of northern Guam, sound measurements would need to be taken at other locations, such as on the beach, at the base of the cliff, and in the forest. Future studies should take into account that if the data are collected using similar measures to those used here (unweighted measures, 5-min L_{eq}, RMS levels, and the various SPL measurements), then new data could be comparable to these results.

Literature Cited

Bishop, D.E. and P.D. Schomer (1998). Community Noise Measurements. Pages 50.1-50.24 *in* Handbook of Measurements and Noise Control. 3rd Edition. Edited by C.M. Harris. Acoustical Society of America, Woodbury, NY.

Bolin, K. and M. Abom. (2010). Air-born sound generated by sea waves. *Journal of the Acoustical Society of America* 127:2771-2779.

DON. (2014). Draft Supplemental Environmental Impact Statement Guam and Commonwealth of the Northern Mariana Islands Military Relocation (2012 Roadmap Adjustments). Prepared for Joint Guam Program Office, Washington, DC by Naval Facilities Engineering Command Pacific, Pearl Harbor, HI. April.

Fritts, T.H. and G.H. Rodda. (1998). The role of introduced species in the degradation of island ecosystems: a case history of Guam. *Annual Review of Ecology and Systematics* 29:113-140.

Harris, C.M. (1998). Introduction. Pages 1.1-1.29 *in* Handbook of Measurements and Noise Control. 3rd Edition. Edited by C.M. Harris. Acoustical Society of America, Woodbury, NY.

Heffner, R.E. and R.S. Heffner (2007). Hearing ranges of laboratory animals. *Journal of the American Association for Laboratory Animal Science* 46:20-23.

PCB Piezotronics, Inc. (2010). Larson Davis Model 831 Technical Reference Manual. Provo, UT. 532 pp.

Raichel, D.R. (2000). The Science and Applications of Acoustics. Springer-Verlag Inc., New York, NY. 598 pp.

Raspet, R. and J. Webster. (2015). Wind noise under a pine tree canopy. *The Journal of the Acoustical Society of America* 137: 651-659.

Small, Jr., A.M. and R.S. Gales. (1998). Hearing Characteristics. Pages 17.1-17.25 *in* Handbook of Measurements and Noise Control. 3rd Edition. Edited by C.M. Harris. Acoustical Society of America, Woodbury, NY.

Wilson, D.K. and M.J. White. (2010). Discrimination of wind noise and sound waves by their contrasting spatial and temporal properties. *Acta Acoustica United with Acoustica* 96: 991-1002.

Wilson, J.H. (1980). Low-frequency wind-generated noise produced by the impact of spray with the ocean's surface. *Journal of the Acoustical Society of America* 68:952-956.

Wilson, J.H. (1983). Wind-generated noise modeling. *Journal of the Acoustical Society of America* 73:211-216.

Yeager, D.M. and A.H. Marsh (1998). Sound Levels and Their Measurement. Pages 11.1-11.18 *in* Handbook of Measurements and Noise Control. 3rd Edition. Edited by C.M. Harris. Acoustical Society of America, Woodbury, NY.

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Appendix A – Sound Level Data Presented as A-weighted Levels

Converting Unweighted to A-weighted Sound Level Measurements

The SPLs recorded in the field were unweighted, but in some cases it is useful to have the results as A-weighted SPLs in order to compare to other studies or to put the results in the context of how humans would perceive the ambient sound. A-weighting not only reflects the sensitivity of humans hearing to frequency ranges, but it also reflects the bandwidth of human hearing. Therefore, for the A-weighted SPLs reported here, the two lowest octaves, centered at 8 Hz and 16 Hz, where the greatest sonic energy and variability occurred, are not considered. The octave bands centered at 125, 250, and 500 Hz are strongly reduced in human hearing. The octave bands centered on 2 and 4 kHz are frequencies of slightly increased sensitivity, and there is some roll off in sensitivity at the octaves above 4 kHz. Table A1 contains the dB adjustments for octave bands going from unweighted to A-weighted SPLs. (This information also is presented in Table 5 of the Discussion.)

Table A1. The Adjustment to Unweighted Octave Band SPLs for A-weighted SPLs

Octave Band Center Frequency	A-weighting dB difference
31.5 Hz	-39.4
63 Hz	-26.2
125 Hz	-16.1
250 Hz	-8.6
500 Hz	-3.2
1 kHz	0
2 kHz	1.2
4 kHz	1
8 kHz	-1.1
16 kHz	-6.6

Directly subtracting or adding the adjustment factor to the unweighted SPLs quickly provides the A-weighted octave band SPLs for L_{eq} and L_{peak}. The new measures will be annotated as L_{Aeq} and L_{Apeak}. Like L_{Zeq}, L_{Aeq} is an integrated SPL evaluated for the 5-min time interval since the preceding sample. The units of A-weighted SPLs are sometimes labeled dBA. Obtaining broadband A-weighted SPLs requires more manipulation of the data. Using the A-weighted octave band SPLs, divide each octave band value 10 and take the anti-log of each value. Then take the sum of the new values across the octave bands. Finally, take the log of the sum and multiply by 10. The calculation can only be done with measurements that were taken as L_{eq}; therefore, we will not be providing broadband peak or maximum SPLs that are A-weighted.

A-weighted SPLs from Northwest Field

Summary Sound Level Measurements

The A-weighted summary values in Table A2 give the same general impression of the data collection sites as the unweighted data. The Cliff Edge location is still the place with the highest overall sound levels when compared to Ritidian Pt #1. On the one day that Ritidian Pt #1 and Ritidian Pt #2 were sampled, they had very similar dBA values, within 1.5 dBA of each other. The conversion to A-weighting does narrow the span between the maximum and minimum L_{eq} values compared to unweighted values (see Table A2 vs. Table 3).

Table A2. Summary L_{Aeq} Values for the Various Data Collection Periods

	15 April	Night of 15-16 April	16 April	17 April	22 April
	Ritidian Pt #1				
min	43.49	43.41	43.82	52.97	48.24
max	49.16	44.36	44.01	56.10	52.31
L_{dcp}	43.85	43.44	43.76	54.00	49.64
	Ritidian Pt #2				
min	-	-	44.50	-	-
max	-	-	45.38	-	-
L_{dcp}	-	-	44.83	-	-
	Cliff Edge				
min	-	50.51	-	57.42	54.54
max	-	57.76	-	62.08	56.19
L_{dcp}	-	51.73	-	58.92	55.02

Values are in dBA. A dash in a cell indicates that data were not taken in that location at that time.

15 April 2014

Figure A1 presents the broadband A-weighted levels for Ritidian Pt #1. Removing the lowest two octave bands and reducing the sensitivity to the lower and higher frequencies smooth out the changes in SPL across time and lowers the overall SPL value. The mid-frequencies between 500 Hz and 8 kHz, which were the more consistent octave bands, contribute the most to the L_{Aeq}. In Figure A1, the two aircraft departures and one arrival prior to 13:00 are notable, although they do not elevate the L_{Aeq} above 50 dBA. The other aircraft events fail to raise the ambient sound level much at all, although the two arrivals around 14:00 also register to some degree on the lower octaves in the graph of peak sound values (Figure A3).

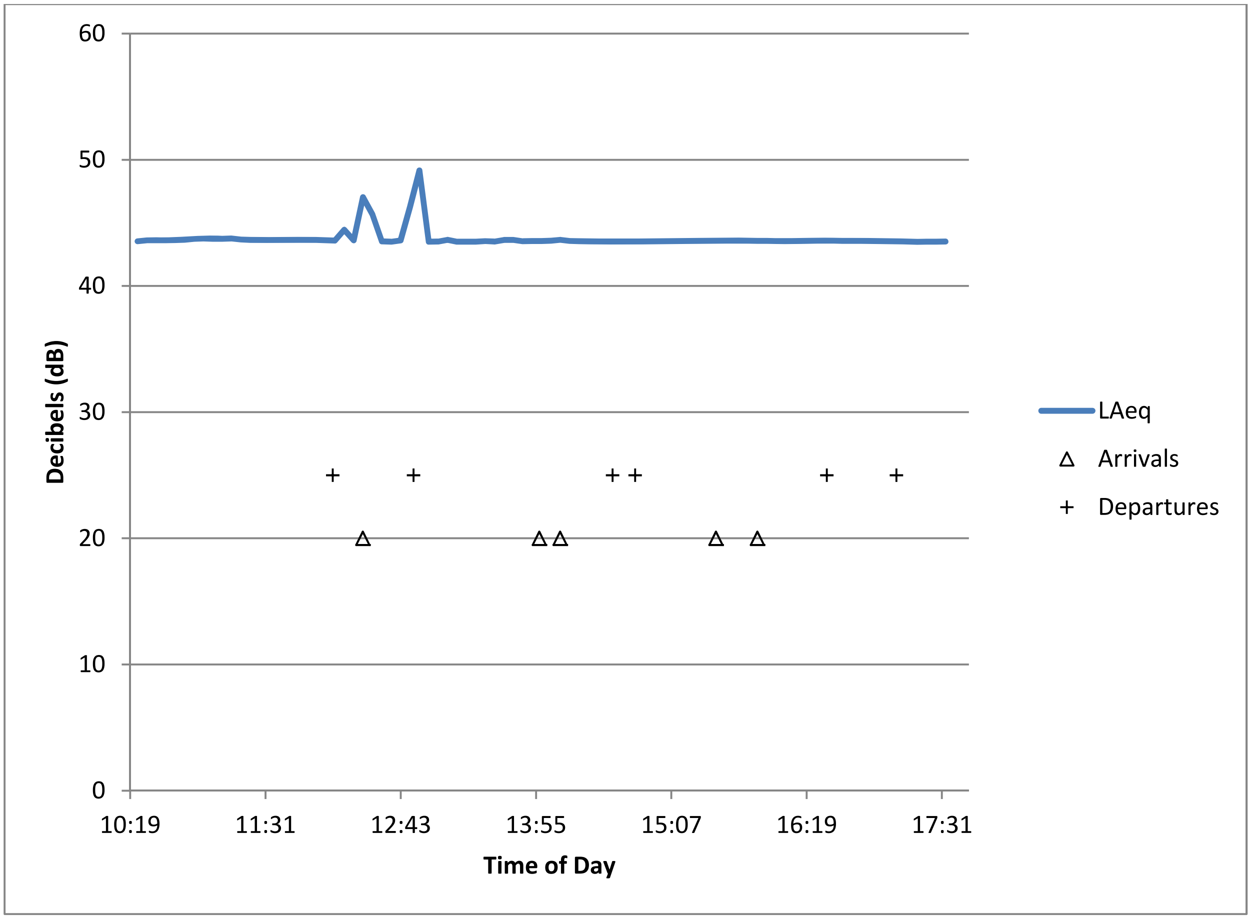


Figure A1. A-weighted Sound Levels (LAeq) across the Frequency Spectrum for 5-minute Samples at Ritidian Pt #1 on 15 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

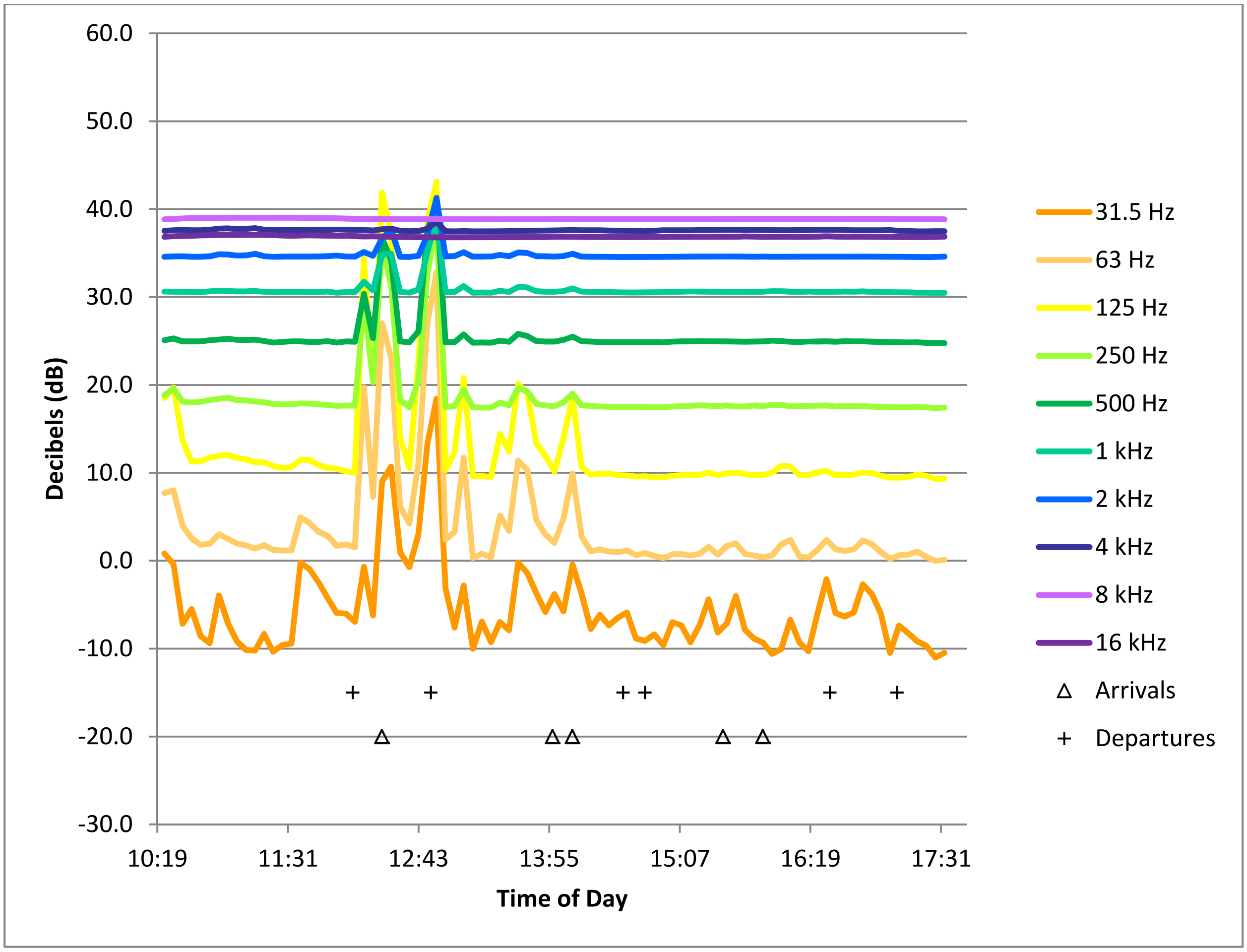


Figure A2. A-weighted Sound Levels (L_{Aeq}) for Octave Bands Integrated Across 5-minute Sample Periods at Ritidian Pt #1 on 15 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

The octave bands are broken out in Figures A2 and A3 in the same way the octave bands were presented for the unweighted SPLs. The maximum, minimum, and average sound level in dBA is also presented in Table A3. It is clear in the figures that the lower frequencies are still the most dynamic elements of the ambient soundscape, but they are less salient to the A-weighted scale. SPL values that are below 0 dBA are below the threshold of hearing for humans. Even though that sound is still present in the environment, it cannot be perceived by human hearing.

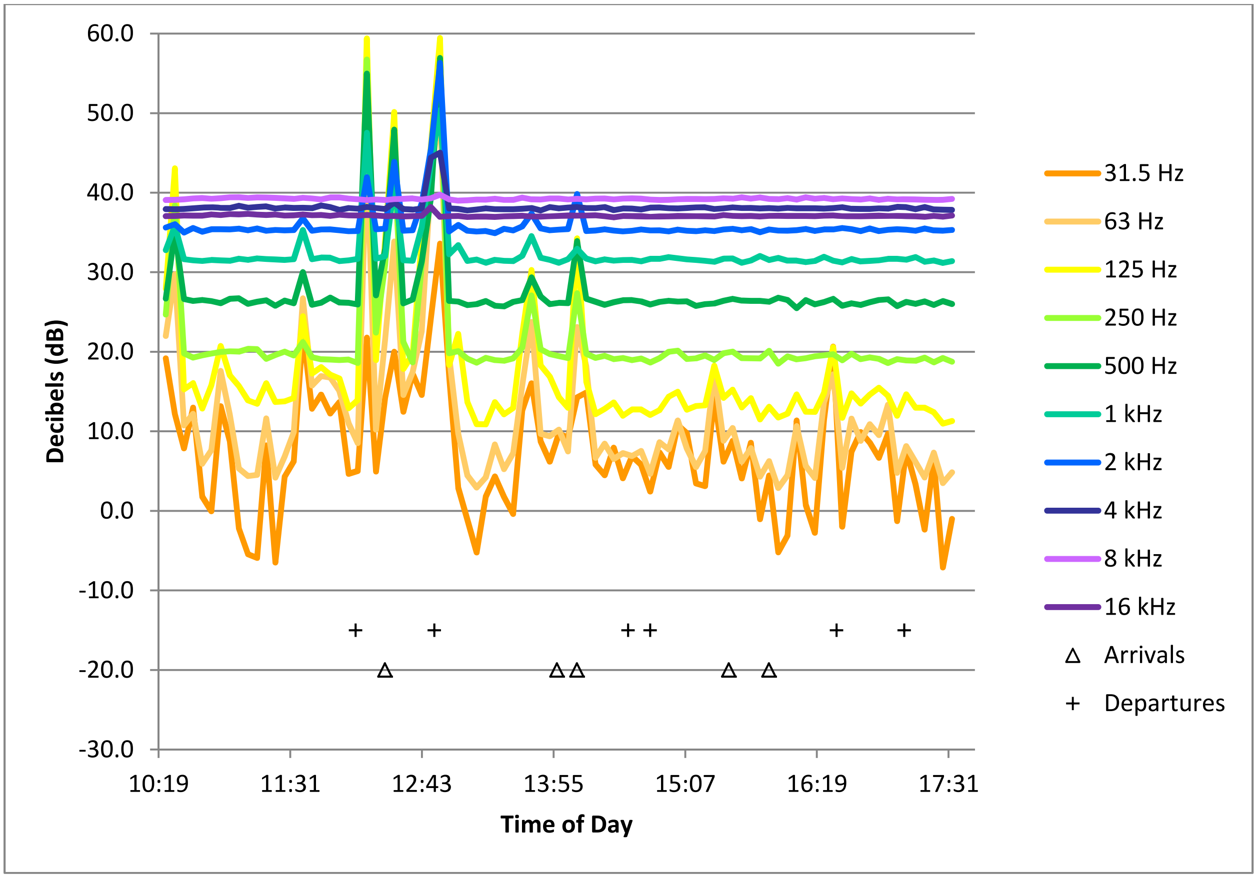


Figure A3. A-weighted Maximum Sound Levels (L_{AFmax}) for Octave Bands within 5-minute Sample Periods at Ritidian Pt #1 on 15 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table A3. Summary dBA Values of Octave Bands for 15 April 2014

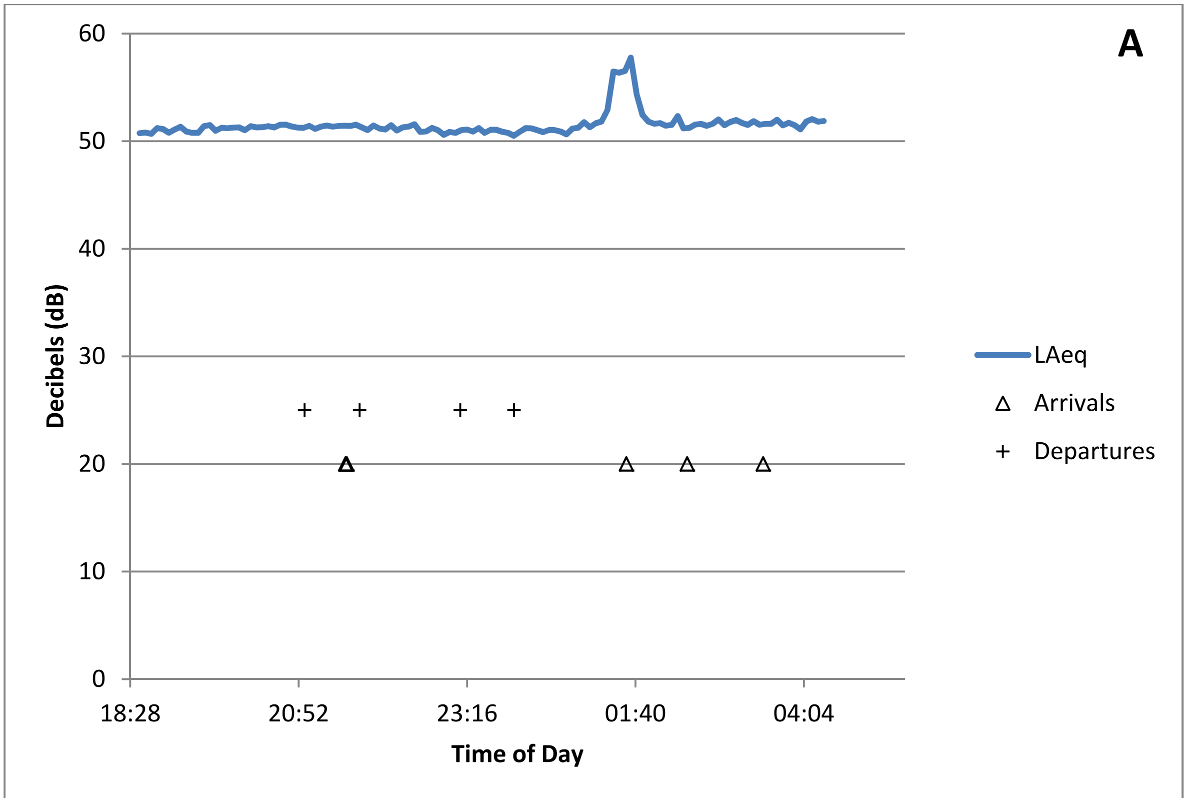
		Octave Band									
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	16 kHz
Ritidian Pt #1											
L_{Zeq}	min	-11.02	-0.02	9.30	17.37	24.75	30.45	34.53	37.45	38.82	36.79
	max	18.43	32.84	43.12	38.32	40.83	39.02	41.27	38.59	39.05	37.08
	L_{dcp}	1.99	15.91	27.79	23.52	27.73	31.10	34.87	37.55	38.84	36.82
L_{ZFmax}	min	-7.11	2.87	10.88	18.52	25.49	31.18	34.92	37.77	38.99	36.91
	max	33.59	50.87	59.44	56.73	56.93	50.38	56.30	45.03	39.73	38.18
	L_{dcp}	16.45	33.10	43.39	39.90	40.19	35.74	39.58	38.35	39.18	37.05

Values are in dBA.

Night of 15-16 April 2014

The overall effect of converting the unweighted measurements to A-weighted is the same for the Cliff Edge and Ritidian Pt #1 data taken during the night of 15 to 16 April as the Ritidian Pt #1 data taken on 15 April: the overall SPL drops and is less variable (Figure A4 and Table A4). The ambient sound level in general is higher at Cliff Edge than Ritidian Pt #1. The aircraft arrival at 01:33 is more detectable at Cliff Edge than at Ritidian Pt #1.

The mid-frequency octave bands are more articulated between 125 Hz and 2 kHz at the Ritidian Pt #1 site than at Cliff Edge (Figures A5 and A6). The source of greater mid-frequency ambient sound at Cliff Edge is not clear, but it may be from wind in the trees. The departure event at 21:45 appears to show a more clearly in the lowest frequency octave band at Ritidian Pt #1 than at Cliff Edge, although the level is so low at both locations that the change in L_{Aeq} is not really detectable (Figure A5), but the change in L_{AFmax} levels is (Figure A6). In some of the higher octave bands, peak levels reach a little over 60 dBA.



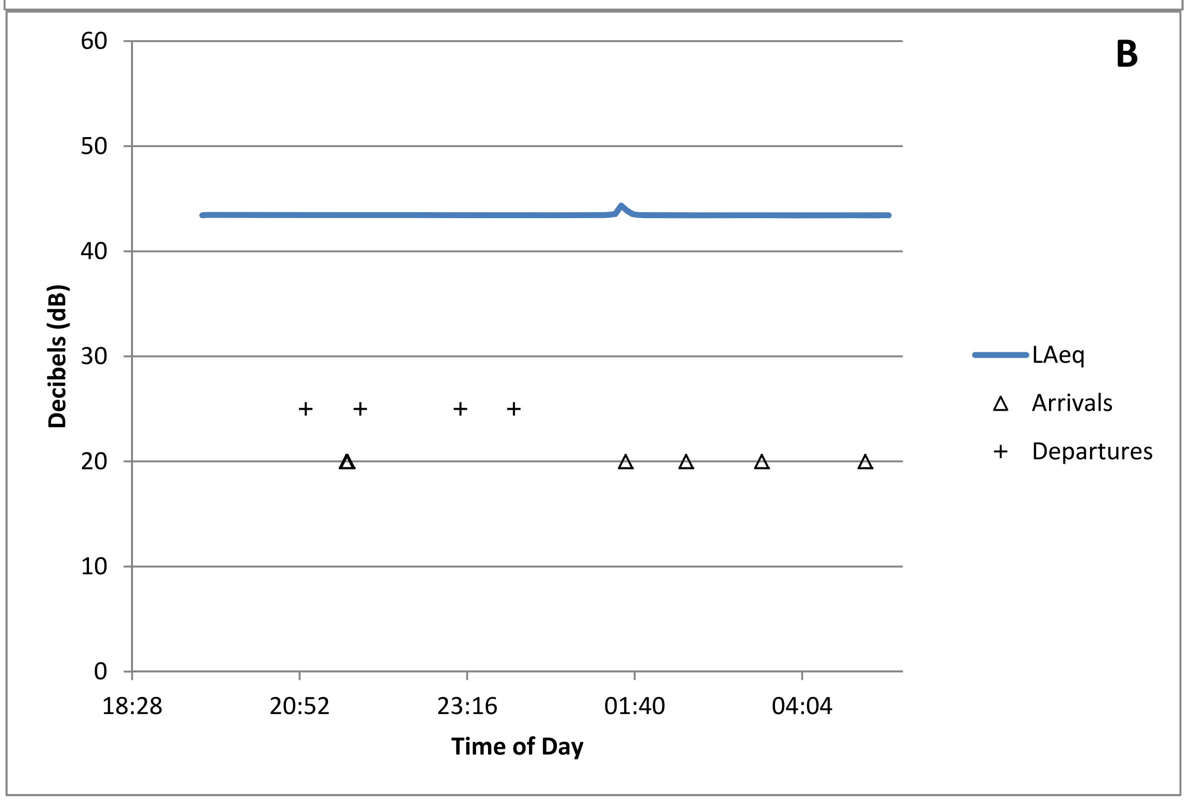


Figure A4. A-weighted Sound Levels (L_{Aeq}) across the Frequency Spectrum for 5-minute Samples at Cliff Edge (A) and Ritidian Pt #1 (B) on the Night of 15-16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

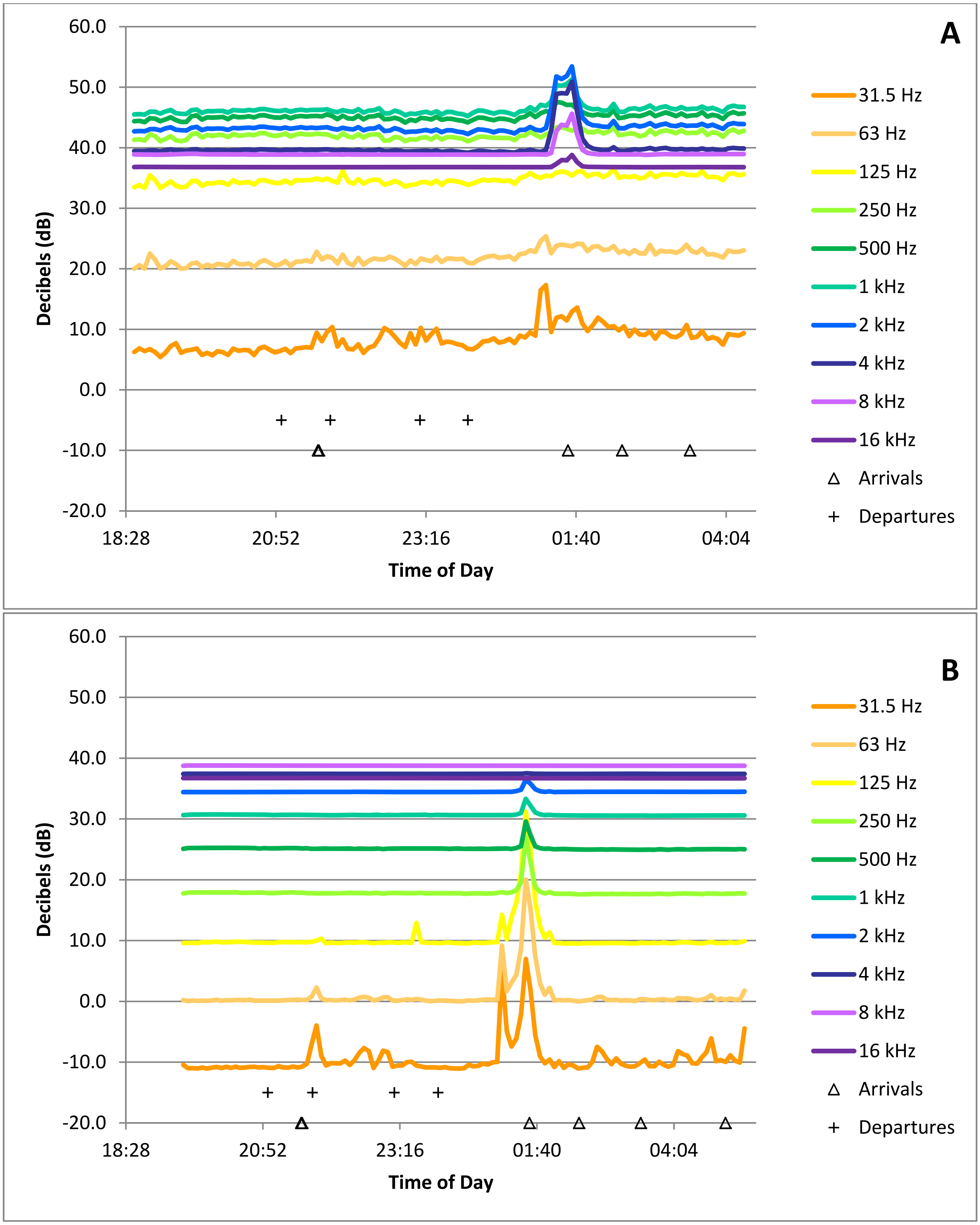


Figure A5. A-weighted Sound Levels (LAeq) for Octave Bands Integrated across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 15 to 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

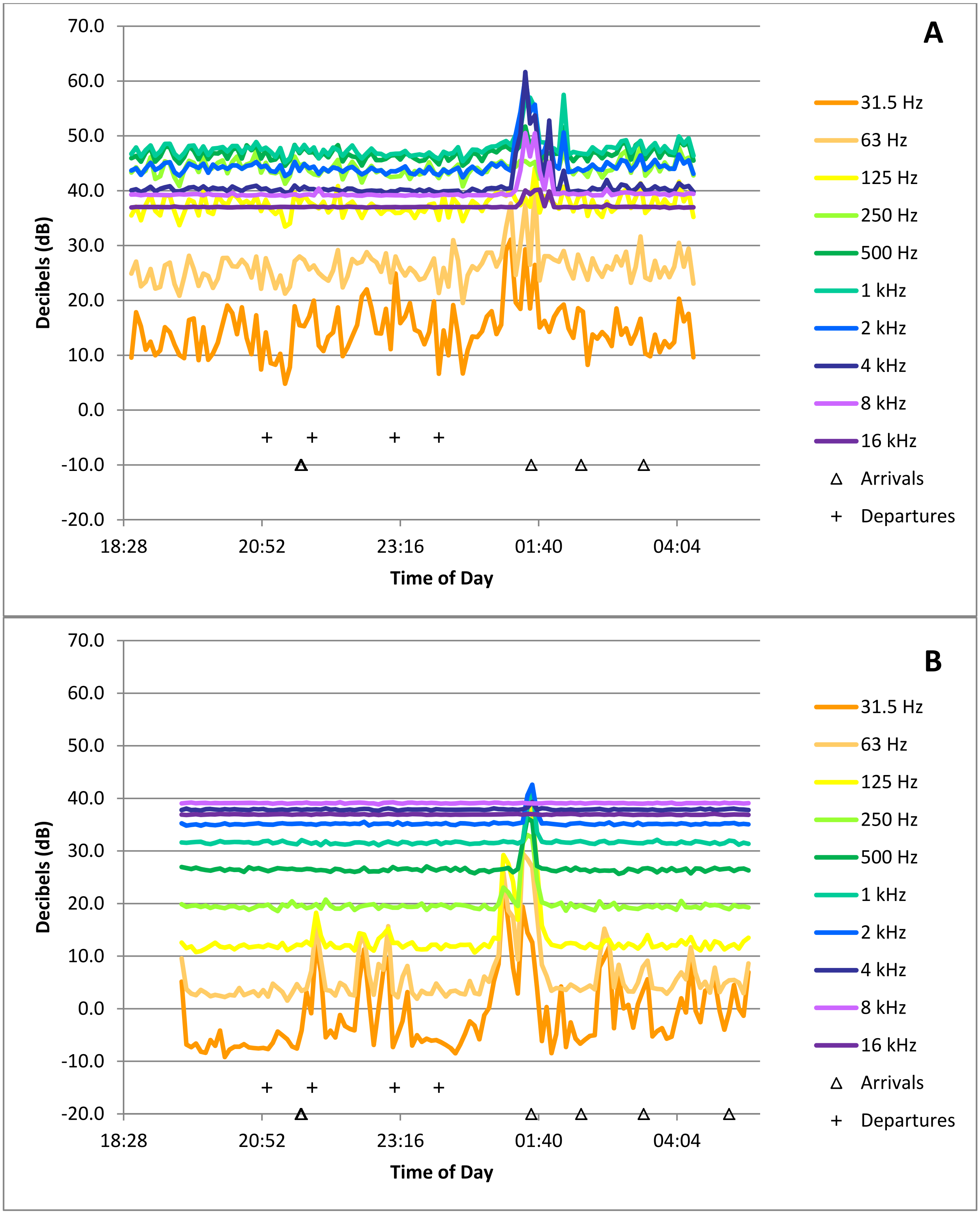


Figure A6. A-weighted Maximum Sound levels, LAFmax, for Octave Bands Integrated across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on the Night of 15 to 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence. Note that the scale on the y-axis is different on the two graphs.

Table A4. Summary dBA Values of Octave Bands for the Night of 15-16 April 2014

		Octave Band									
		31.5 Hz	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1											
L_{Zeq}	min	-11.06	-0.01	9.49	17.58	24.92	30.53	34.39	37.39	38.73	36.67
	max	6.97	20.01	31.21	26.97	29.59	33.31	36.44	37.52	38.77	36.72
	L_{dcp}	-6.62	4.51	14.86	18.29	25.26	30.72	34.49	37.41	38.76	36.71
L_{ZFmax}	min	-8.47	1.90	10.69	18.65	25.63	31.08	34.84	37.63	38.86	36.81
	max	24.06	29.55	39.59	33.05	36.22	42.27	42.60	39.30	39.26	37.06
	L_{dcp}	7.93	15.40	23.45	21.76	27.27	32.26	35.50	37.89	39.09	36.94
Cliff Edge											
L_{Zeq}	min	6.07	20.47	33.58	41.07	44.14	45.23	42.25	39.17	38.83	36.77
	max	17.30	25.39	36.54	43.38	47.56	51.29	53.44	50.93	45.63	38.79
	L_{dcp}	9.00	22.06	34.80	42.11	45.20	46.45	44.26	40.88	39.26	36.85
L_{ZFmax}	min	4.82	19.53	33.46	40.79	44.54	45.16	42.44	39.16	39.01	36.85
	max	31.07	40.89	44.09	48.03	51.69	57.47	60.55	61.64	50.50	40.21
	L_{dcp}	18.15	28.02	37.84	44.35	46.97	48.50	46.54	44.65	40.42	37.20

Values are in dBA.

16 April 2014

A-weighted measurements at Ritidian Pt #1 and Ritidian Pt #2 show the two sites to be similar in SPL and variability (Figure A7). Ritidian Pt #2 has slightly higher average sound levels than Ritidian Pt #1 (Table A5). The two sites are situated relatively close together, separated by a few hundred meters. Aircraft events seem to have very little effect on broadband L_{Aeq} levels across the data collection period. The SPLs of the lower octave bands are quite variable at both sites (Figures A8 and A9), but those octave bands are deemphasized in A-weighting; therefore, that variability contributes little to the overall L_{Aeq}.

At Ritidian Pt #1, the variability in L_{AFmax} values in the mid-frequency octave bands, which are quite salient to human hearing, is high enough to be noticeable through much of the day (Figure A9B). There is an interesting peak at about 11:00, which appears to have the greatest amount of energy in the 4-kHz octave band, but other high-frequency octave bands show elevated sound levels, too. The peak does not have corresponding energy in the lowest octave bands. This event is apparent at Ritidian Pt #2 and not at Ritidian Pt #1 (Figure A9). It occurs about 25 min after the aircraft landing event at 10:34. It is not clear what kind of sound source would cause this transient sound peak.

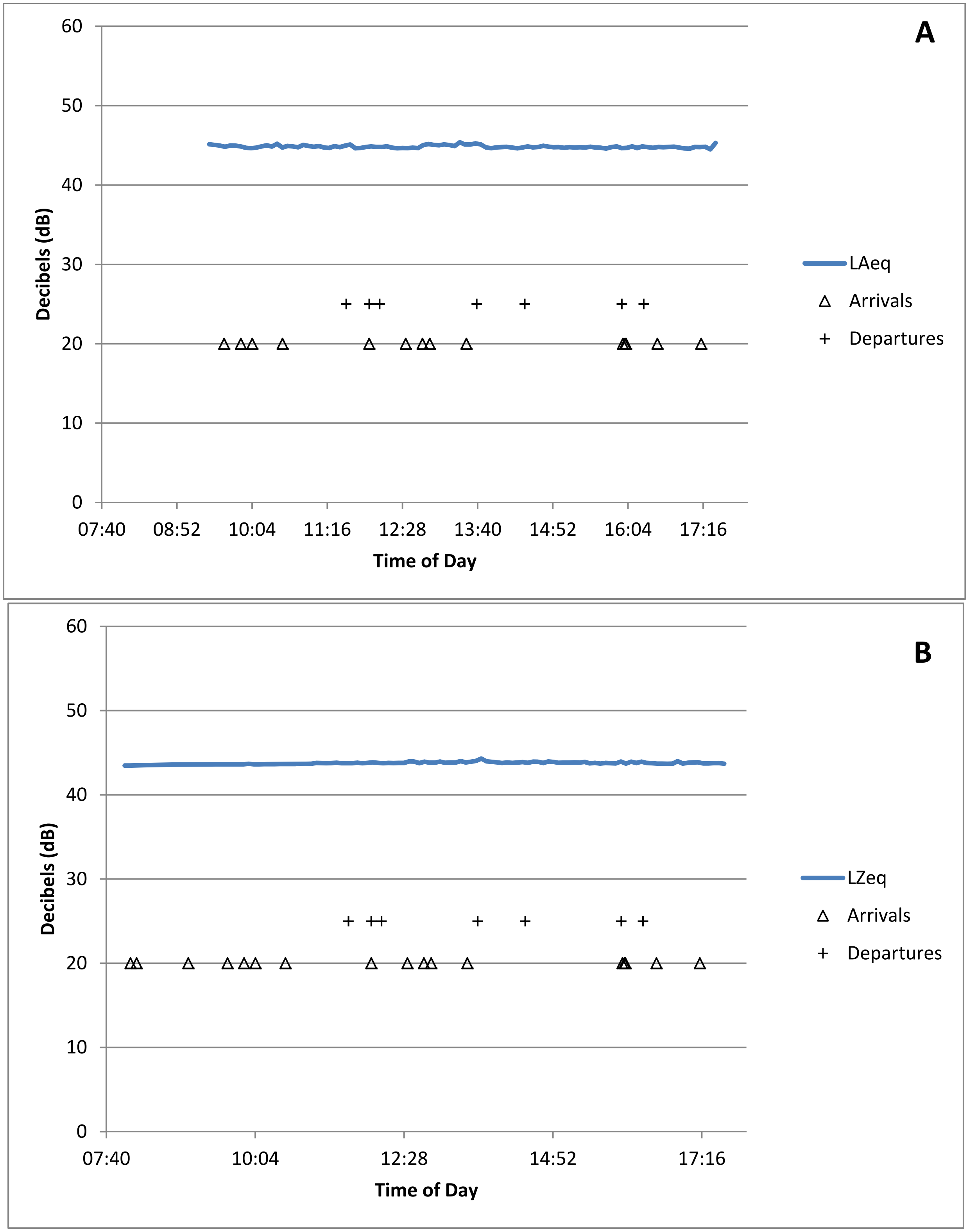
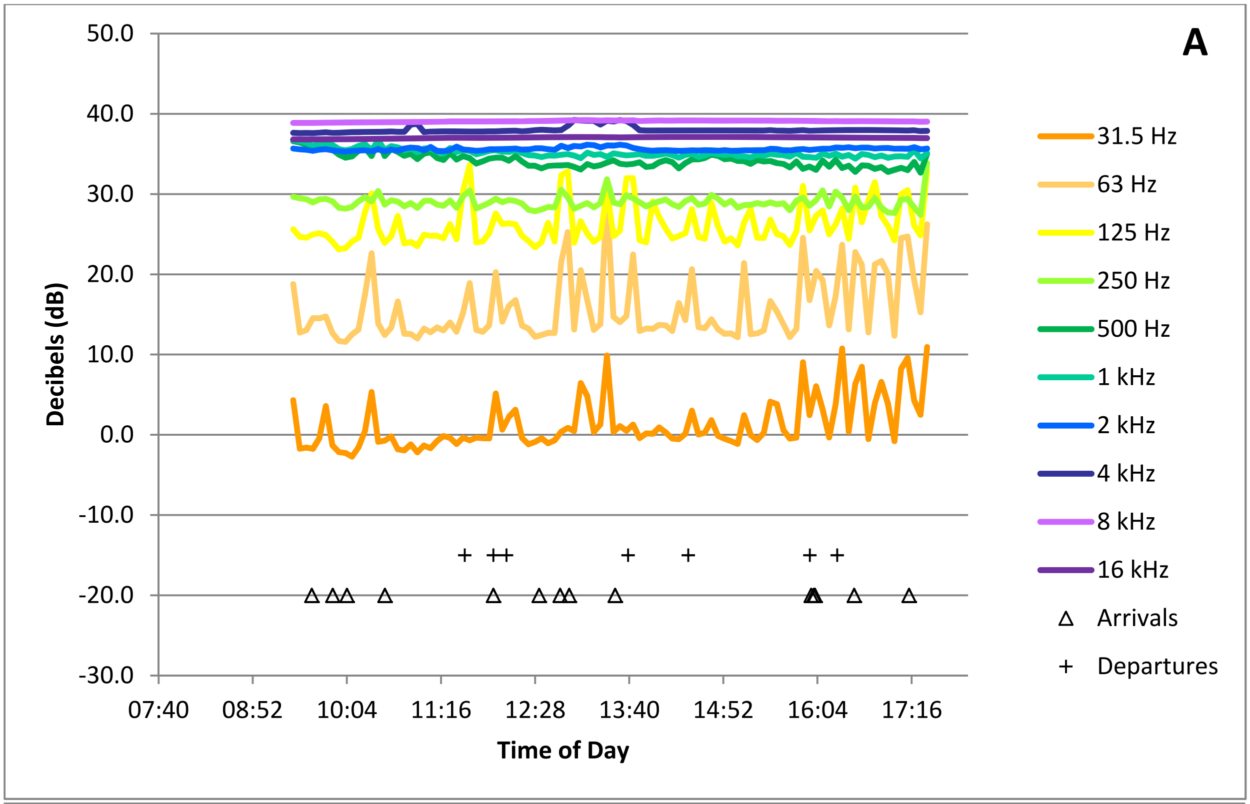


Figure A7. A-weighted Sound Levels (L_{Aeq}) across the Frequency Spectrum for 5-minute Samples at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



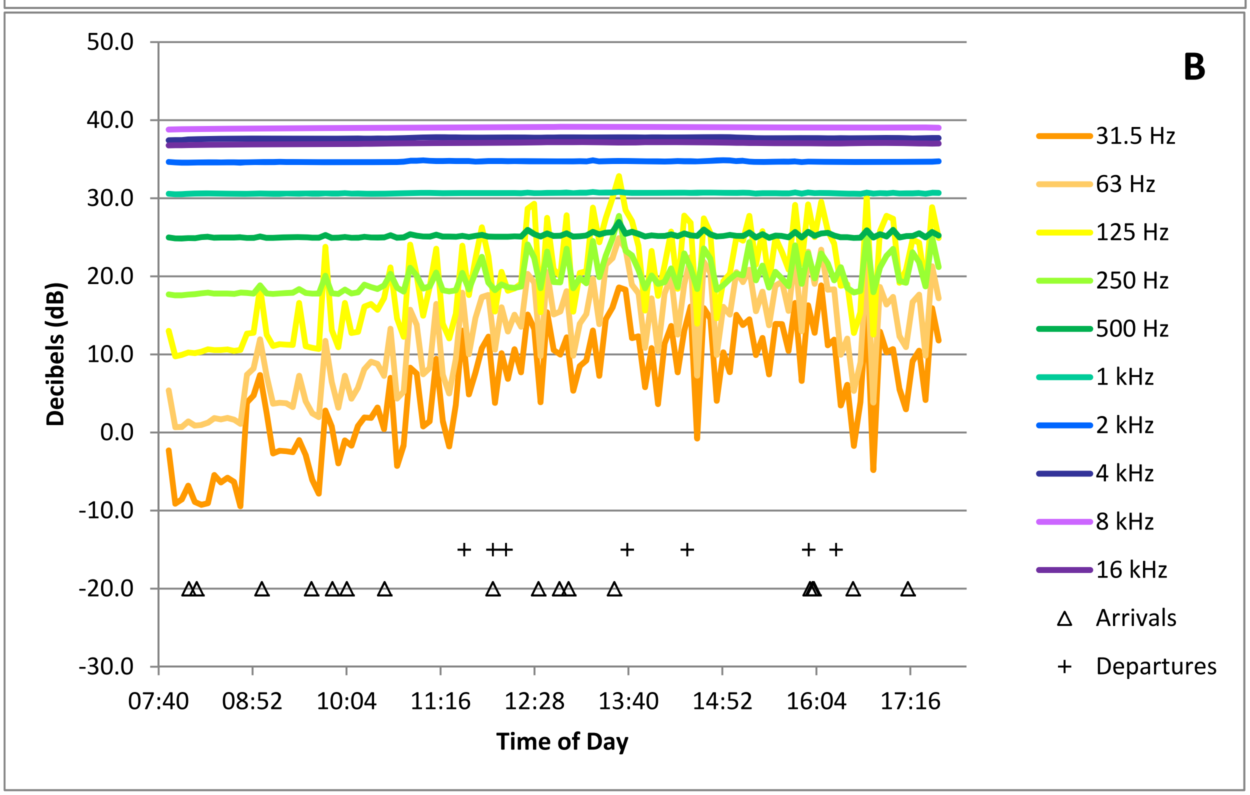
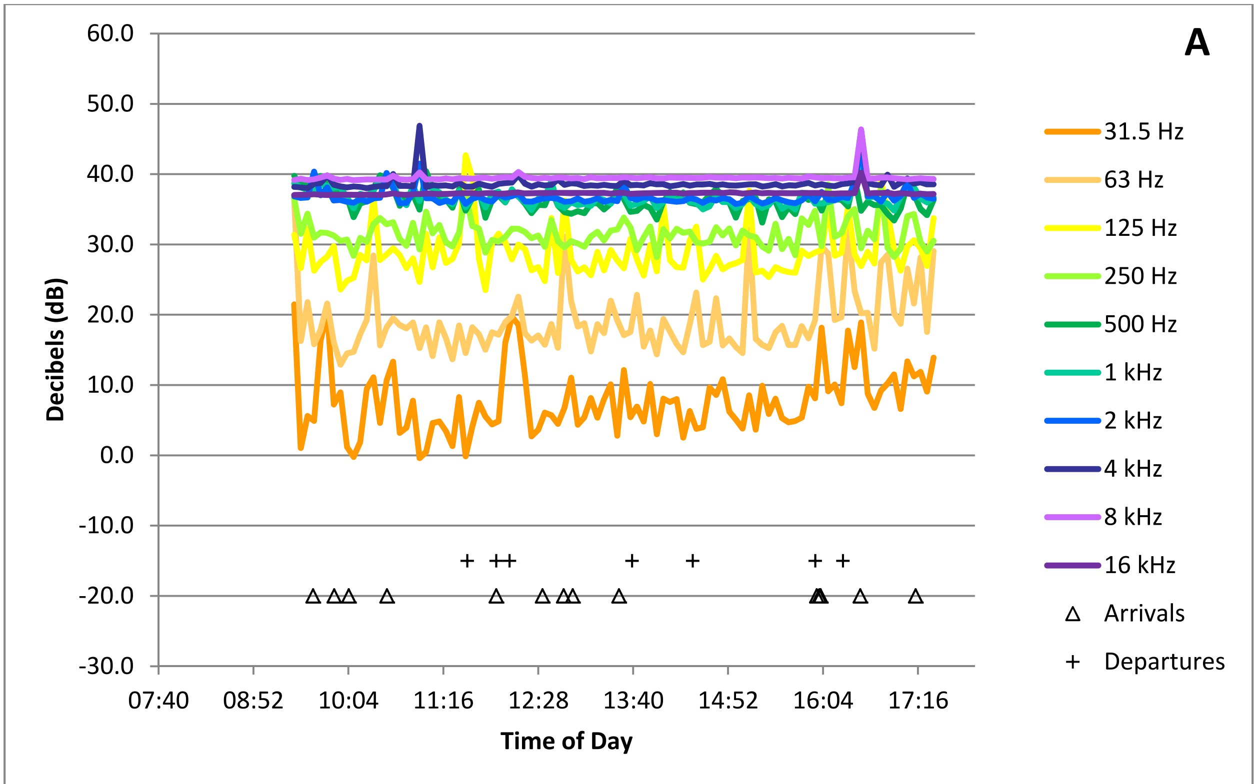


Figure A8. A-weighted Sound Levels (L_{Aeq}) for Octave Bands Integrated across 5-minute Sample Periods at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



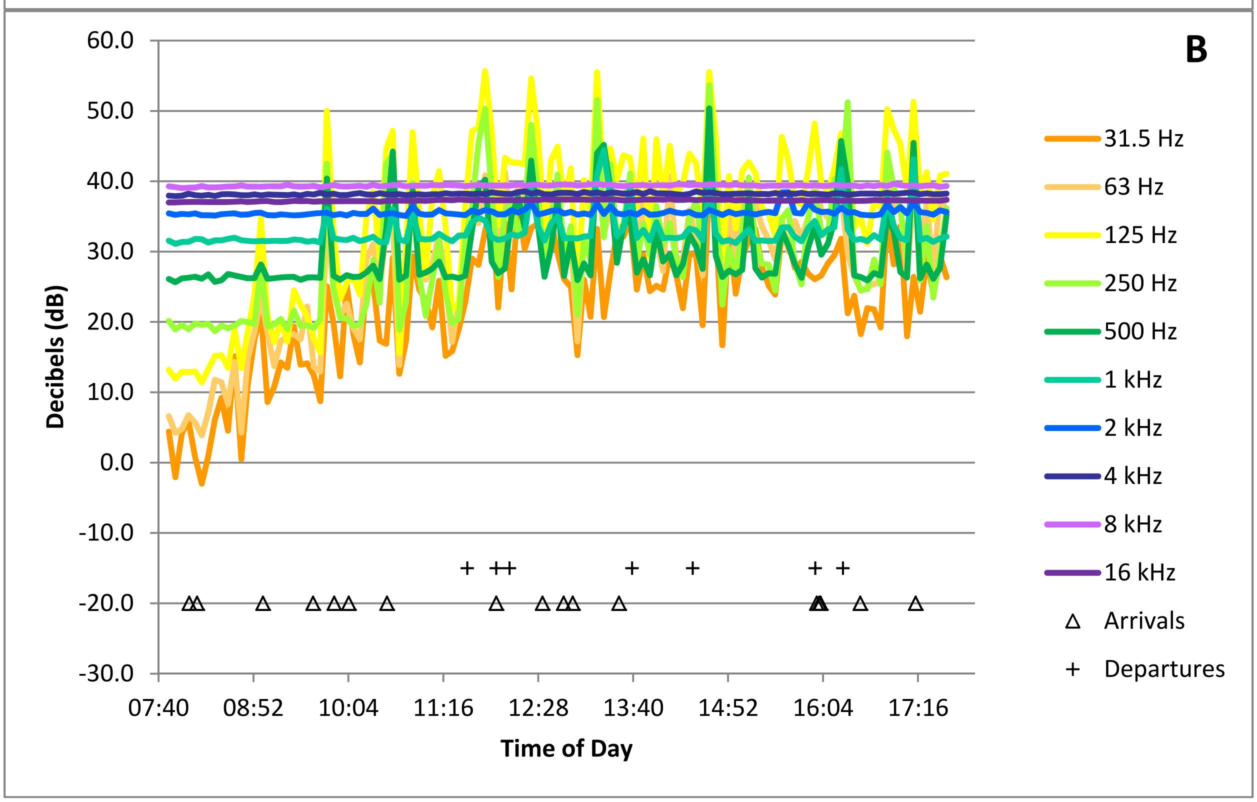


Figure A9. A-weighted Maximum Sound Levels (L_{AFmax}) for Octave Bands Integrated across 5-minute Sample Periods at Ritidian Pt #2 (A) and Ritidian Pt #1 (B) on 16 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table A5. Summary dBA Values of Octave Bands for 16 April 2014

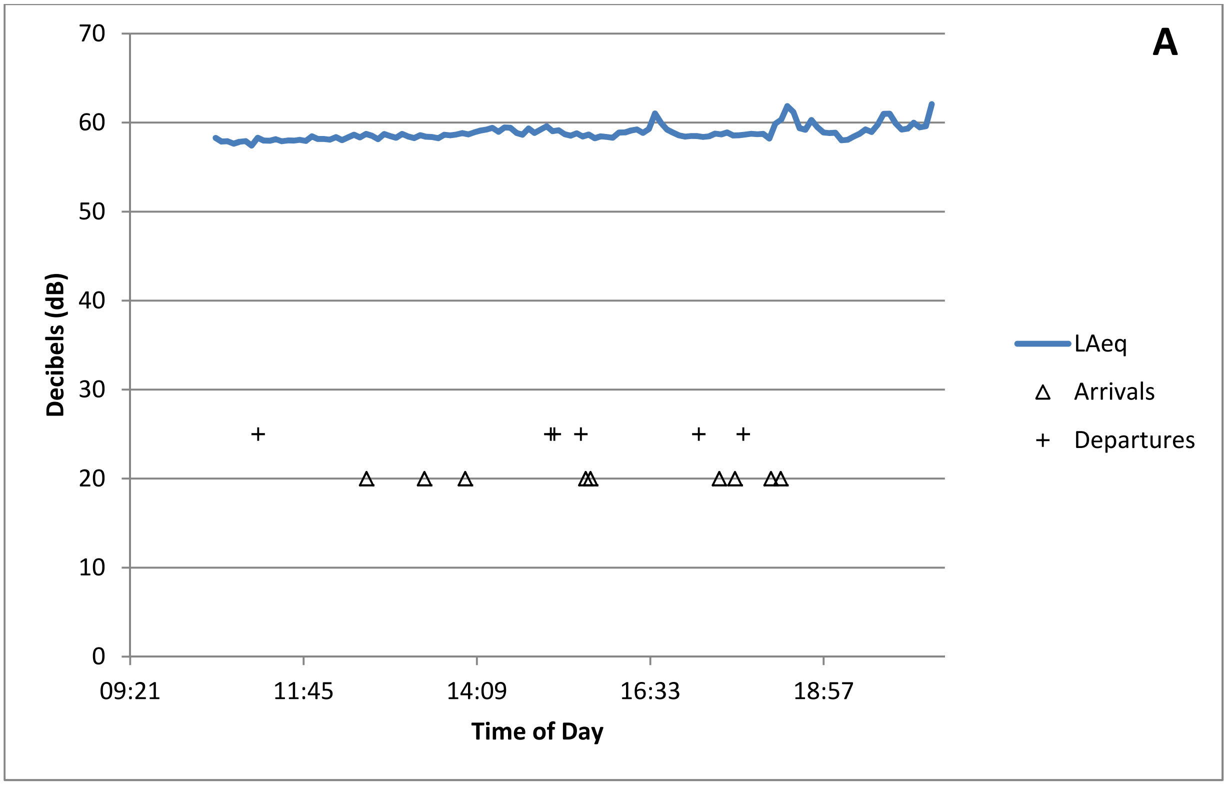
		Octave Band									
		31.5 Hz	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1											
L_{Zeq}	min	-4.81	3.83	12.04	17.93	24.92	30.56	34.61	37.62	38.99	36.98
	max	18.84	24.90	32.82	27.73	26.95	30.82	34.86	37.85	39.14	37.19
	L_{dcp}	10.46	16.40	23.34	19.81	23.97	29.35	33.40	36.43	37.76	35.78
L_{ZFmax}	min	12.65	13.87	15.58	18.88	25.92	31.22	35.07	38.02	39.20	37.10
	max	39.63	46.55	55.65	53.67	50.36	44.44	38.43	38.58	39.66	37.48
	L_{dcp}	28.44	34.85	44.00	39.34	35.46	33.30	34.41	36.94	38.11	36.00
Ritidian Pt #2											
L_{Zeq}	min	-2.19	12.00	23.37	27.40	32.67	34.42	35.33	37.71	38.93	36.85
	max	10.95	29.26	33.60	33.86	36.67	36.71	36.16	39.24	39.20	37.12
	L_{dcp}	2.84	18.31	27.13	29.10	34.29	35.17	35.61	38.02	39.06	37.01
L_{ZFmax}	min	-0.39	13.67	23.51	28.17	33.12	34.82	35.76	37.99	39.19	37.04
	max	19.72	32.36	42.69	38.54	40.41	42.95	43.76	46.88	46.35	40.21
	L_{dcp}	11.07	23.24	31.10	32.10	36.58	36.89	36.97	39.00	39.61	37.29

Values are in dBA.

17 April 2014

Ambient sound levels obtained from Cliff Edge and Ritidian Pt #1 during the day on 17 April are generally higher than the other previous day's measurements (Figure A10 and Table A6). At Cliff Edge, the SPL reaches over 60 dBA a number of times after 16:30. The last two aircraft events of the recording period (two arrivals) also appear to be somewhat detectable at both sites, although the changes in SPL at Ritidian Pt #1 are slight. The other aircraft events are not clearly evident in the broadband L_{Aeq} values.

The octave bands show that, at the Cliff Edge site in particular, the greatest variability is in the low-frequency octaves centered on 31.5 and 63 Hz and the mid-frequency octaves centered on 2 and 4 kHz (Figure A11). The last two aircraft arrivals do correlate with SPLs increases across octave bands up to 16 kHz at both locations. There are L_{AFmax} values, especially at Ritidian Pt #1, that suggest some aircraft events, such as the arrival at 14:00, may correlate with increased sound levels at a variety of octaves that are not evident in the L_{Aeq} measures (Figure A12B). There are other peaks, such as those at 16:37 and 19:47 (see Figure A11A), that have no determined source at this time; they are not associated with aircraft events. Interestingly, the greatest L_{AFmax} values at Ritidian Pt #1 occur about 10 to 15 min after the last landing event at 18:22 (Figure A12), so that increase in peak levels may not be related to aircraft activity. Peak SPL values for some octave bands reach over 70 dBA for that period of elevated sound.



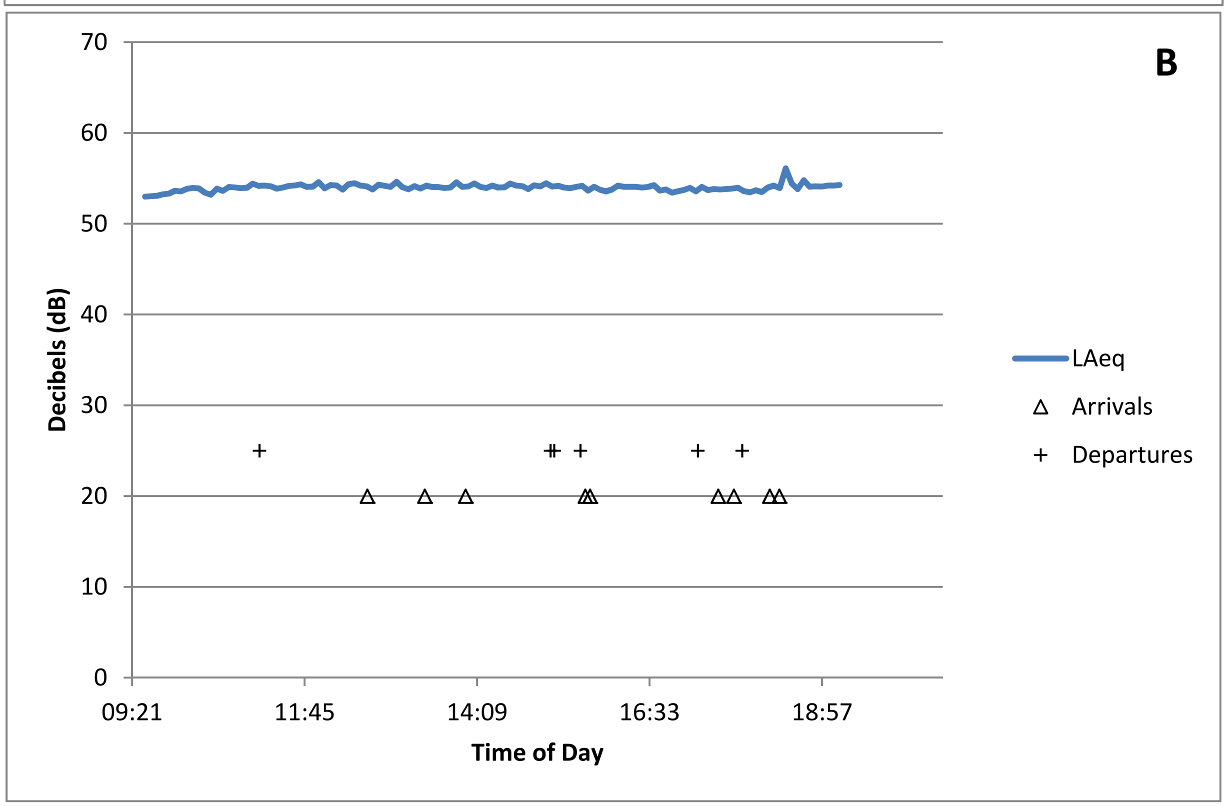


Figure A10. A-weighted Sound Levels (L_{Aeq}) across the Frequency Spectrum for 5-minute Samples at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

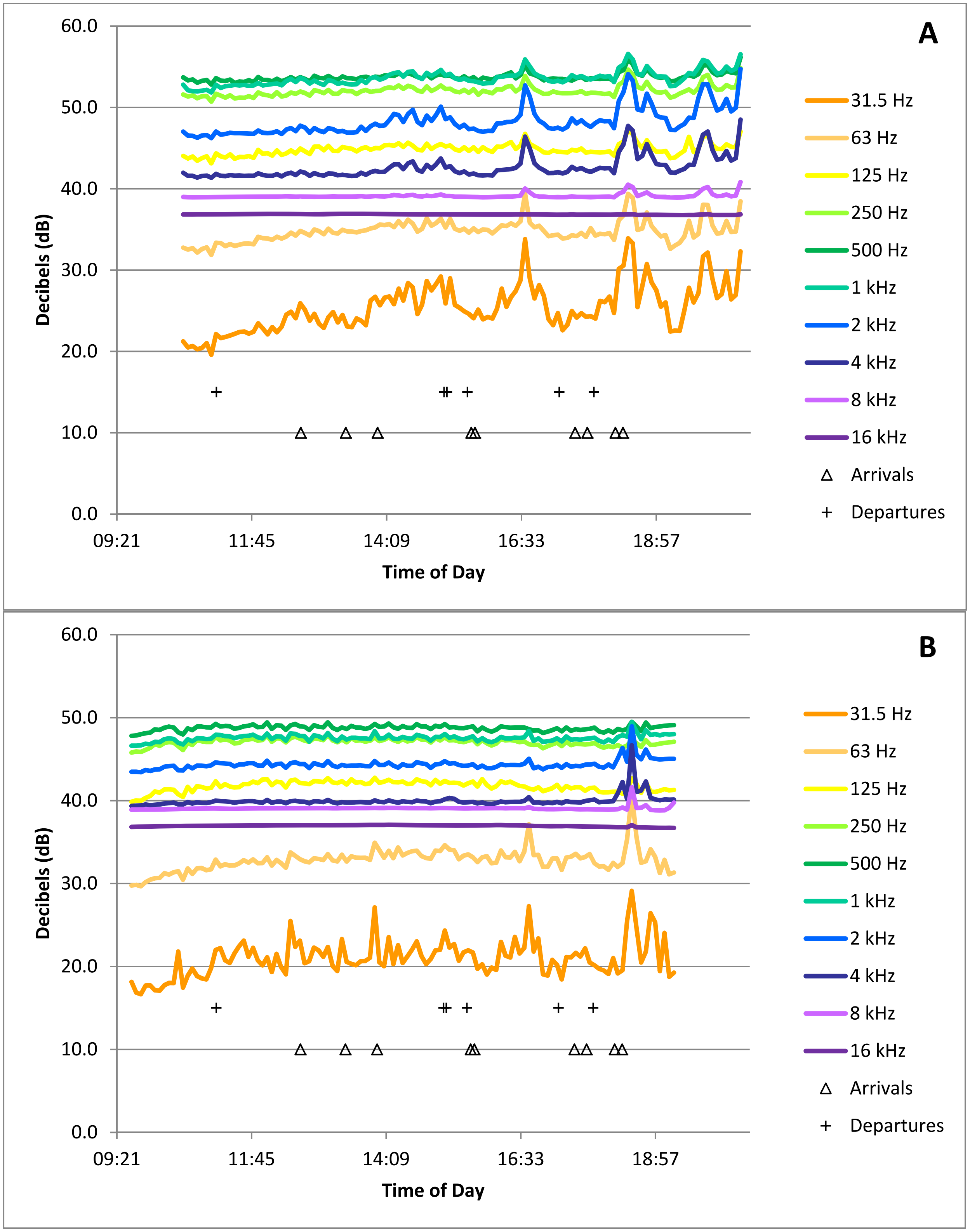
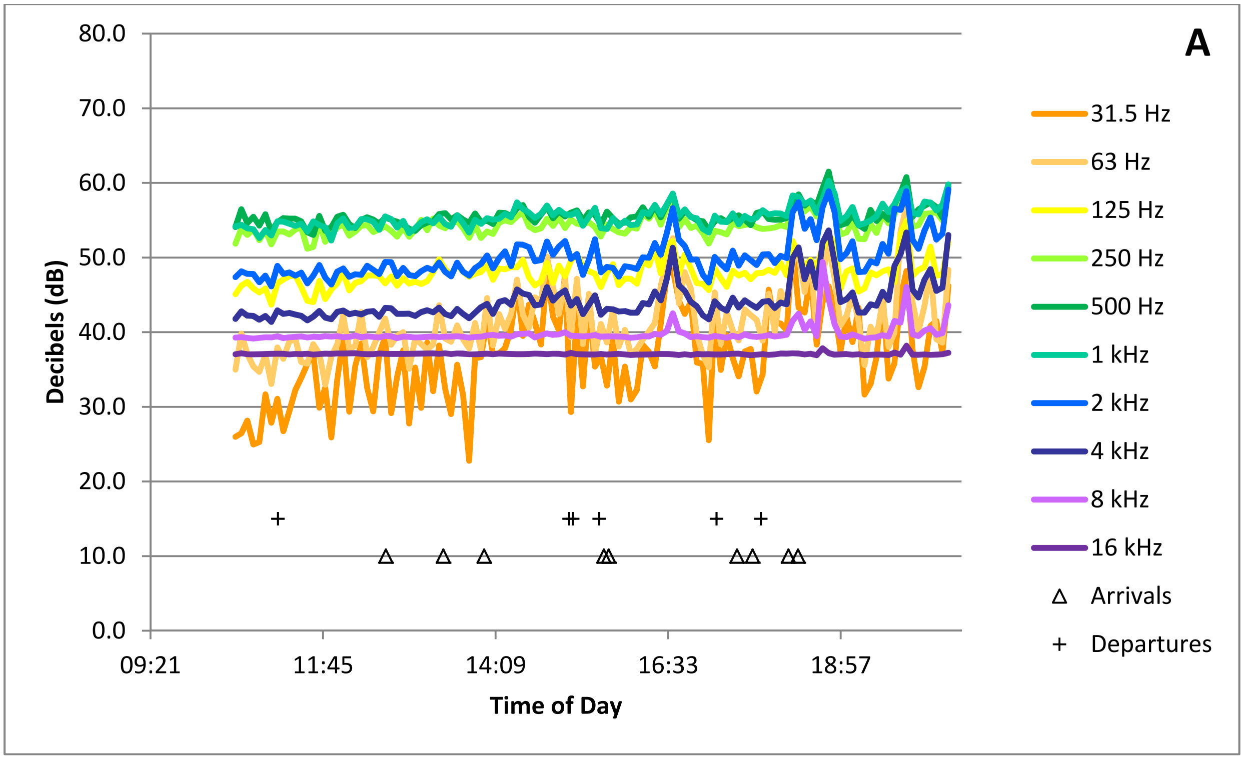


Figure A11. A-weighted Sound Levels (L_{Aeq}) for Octave Bands Integrated across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



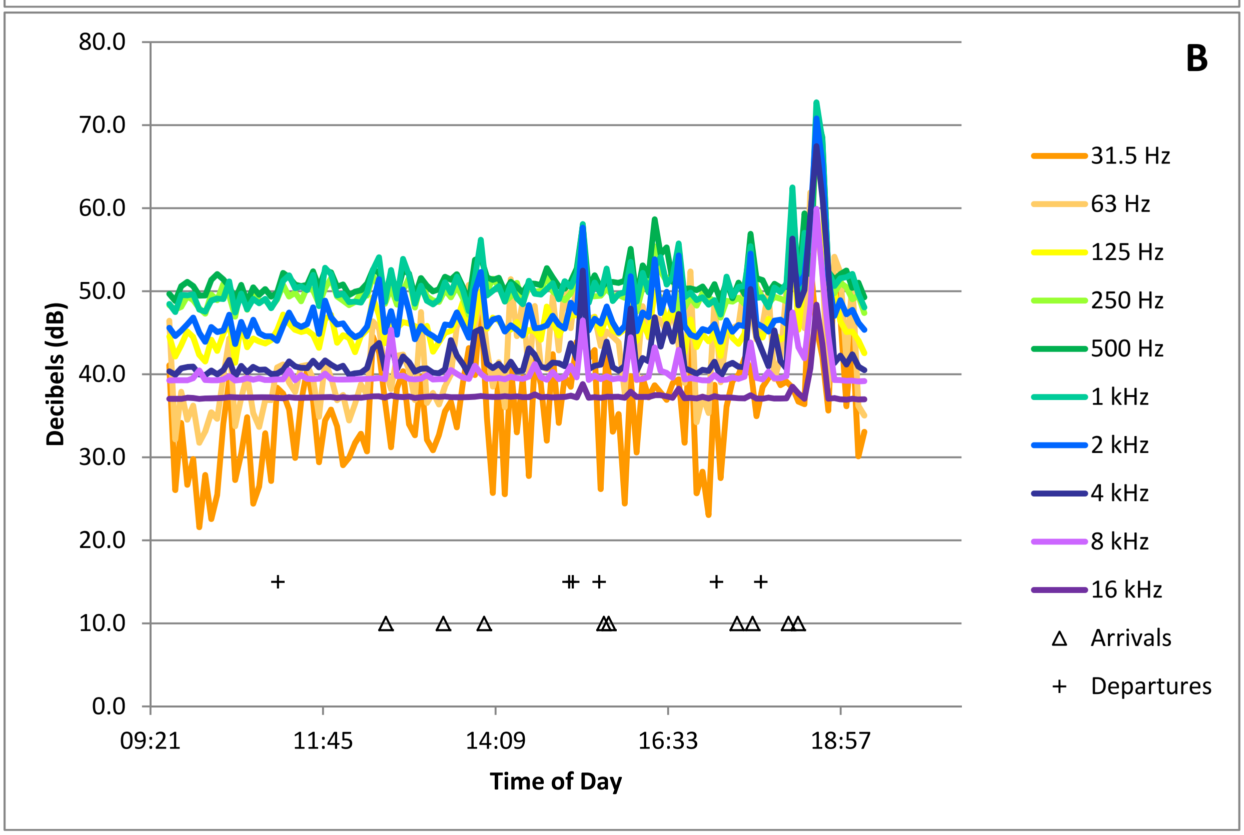


Figure A12. A-weighted Maximum Sound Levels (L_{AFmax}) for Octave Bands Integrated across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table A6. Summary dBA Values of Octave Bands for 17 April 2014

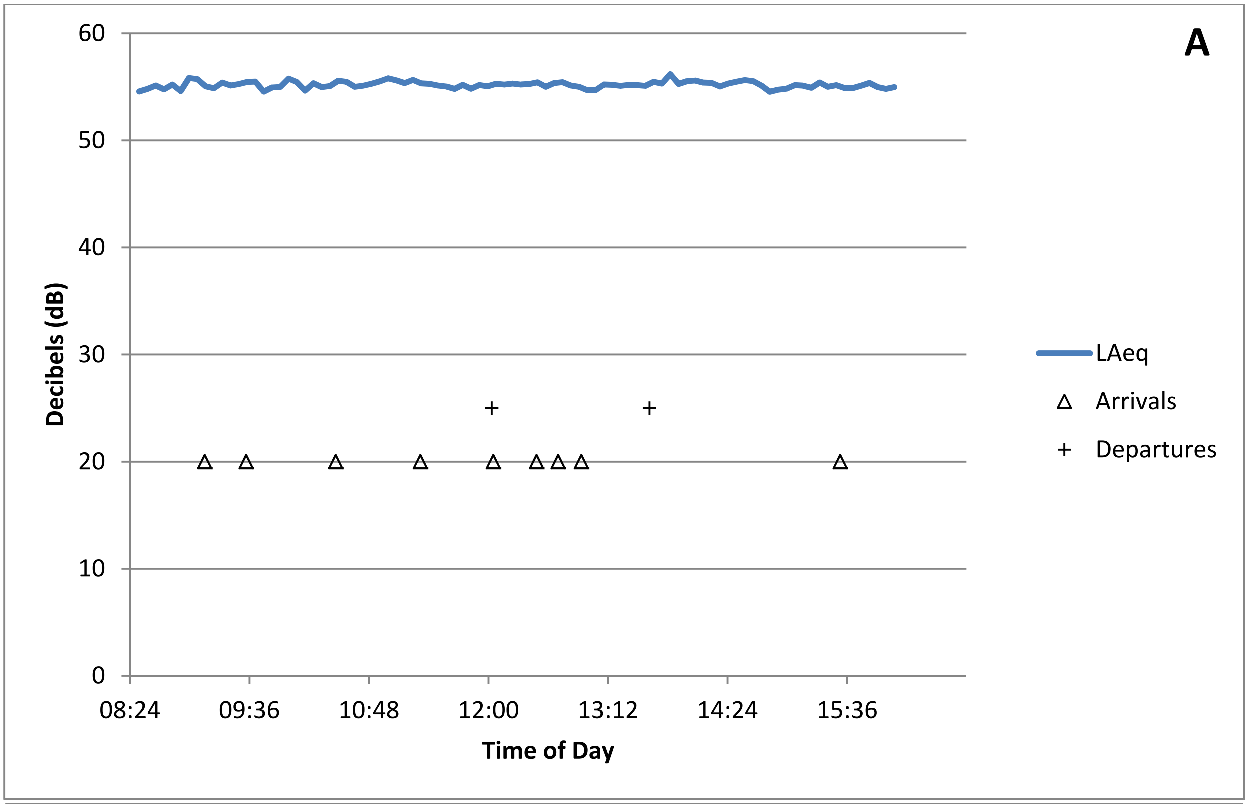
		Octave Band									
		31.5 Hz	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1											
L_{Zeq}	min	18.44	31.11	40.84	46.32	48.16	47.02	43.77	39.58	38.81	36.70
	max	29.10	40.82	42.75	47.92	49.50	49.47	48.95	46.68	41.61	37.08
	L_{dcp}	21.65	33.09	41.79	47.06	48.76	47.57	44.42	40.07	39.07	36.95
L_{ZFmax}	min	23.04	34.22	42.21	46.82	48.71	47.18	43.92	39.69	39.14	36.93
	max	53.41	61.90	67.89	69.16	71.30	72.73	70.79	67.46	59.91	48.37
	L_{dcp}	40.36	47.45	50.67	53.50	55.23	55.49	52.95	49.53	43.21	37.84
Cliff Edge											
L_{Zeq}	min	22.45	32.61	43.75	51.21	53.22	52.60	46.89	41.56	38.91	36.77
	max	33.91	39.41	47.27	54.83	56.17	56.58	54.74	48.50	40.82	36.92
	L_{dcp}	26.56	35.02	44.91	52.10	53.80	53.72	48.72	42.92	39.14	36.84
L_{ZFmax}	min	22.78	35.28	45.46	51.88	53.73	53.36	46.67	41.71	39.12	36.92
	max	51.80	56.95	54.90	60.37	61.50	60.28	59.10	53.64	49.39	38.18
	L_{dcp}	40.80	44.41	48.41	54.73	55.86	55.72	51.36	45.39	40.18	37.08

Values are in dBA.

22 April 2014

As was seen on the other days, the broadband L_{Aeq} values are lower at Ritidian Pt #1 than at Cliff Edge (Figure A13 and Table A7). The two sites do show a reversed relationship for variability of ambient SPLs: Ritidian Pt #1 is more variable than Cliff Edge. This same relationship was true for the unweighted SPLs. The aircraft arrival at 12:29 appears to elevate L_{Aeq} values at Ritidian Pt #1, but not at Cliff Edge. The other aircraft events during the data collection period do not appear to have an effect on the broadband L_{Aeq} at either location.

The breakdown of the SPLs into octave bands shows a similar picture to the broadband L_{Aeq} data (Figures A14 and A15). The greater variability in the SPL data at Ritidian Pt #1 is reflected in the octave bands from 31.5 Hz to 2 kHz, while the greatest variability at Cliff Edge is in the lowest two octave bands. The variability at Ritidian Pt #1 would be easier for the human listener to detect than the SPL changes at Cliff Edge on this day. There are two brief peaks in the L_{AFmax} at Ritidian Pt #1 that are not clearly evident in the Cliff Edge data (Figure A15). The second peak coincides in time with the aircraft arrival at 12:29, but the first peak does not correlate well with aircraft events. The peak occurs about 13 minutes before the aircraft departure and arrival at 12:02 and 12:03, respectively.



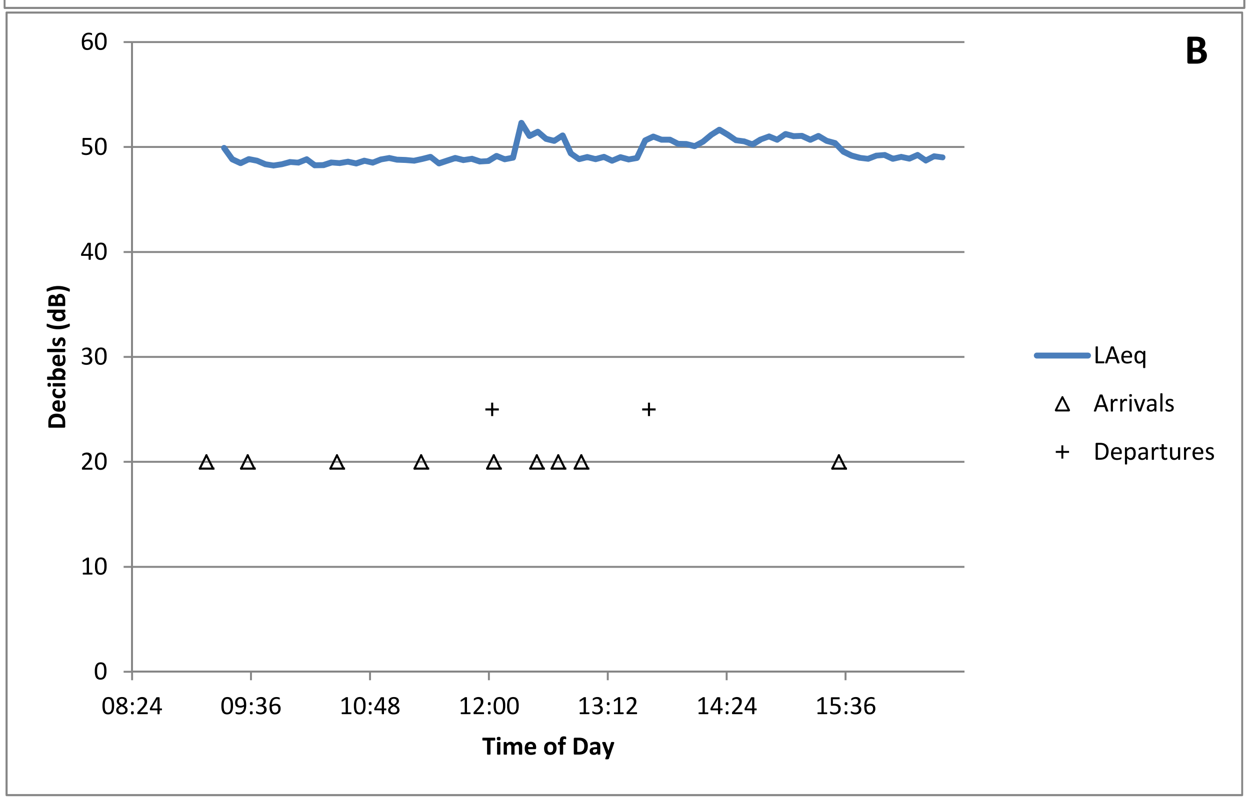
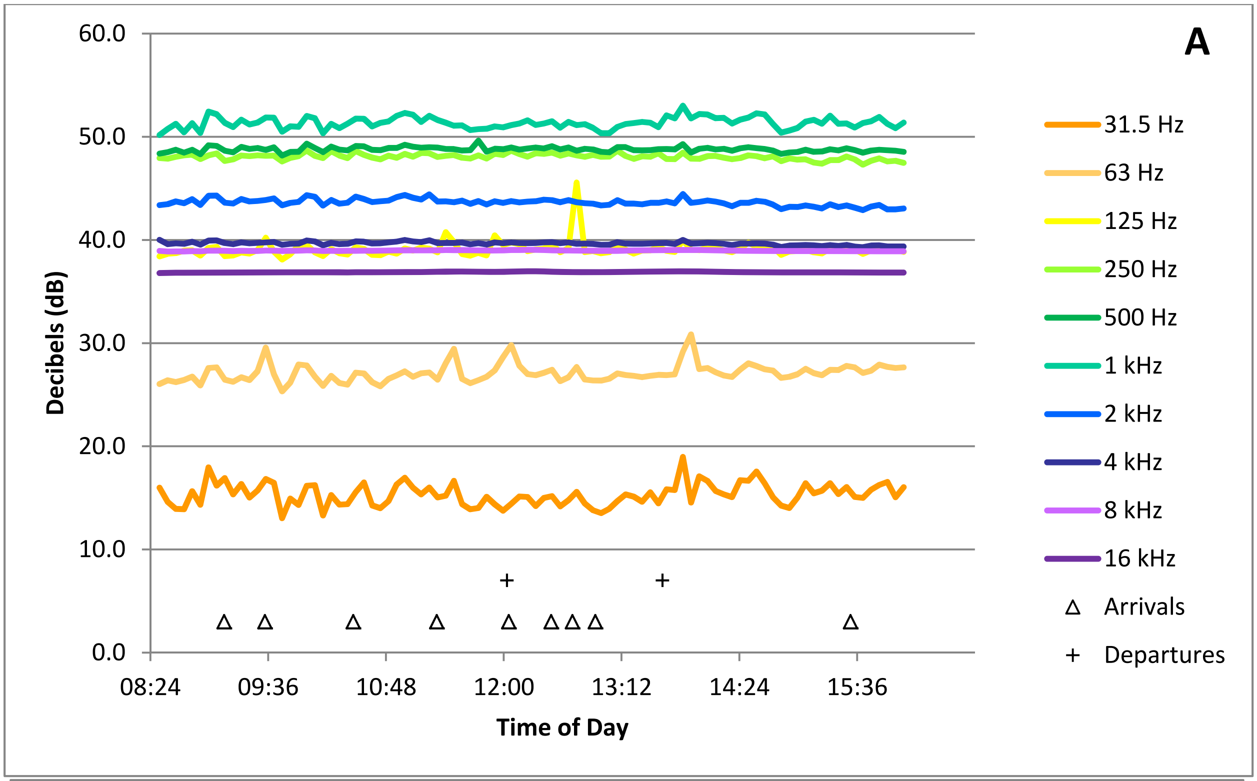


Figure A13. A-weighted Sound Levels (L_{Aeq}) across the Frequency Spectrum for 5-minute Samples at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.



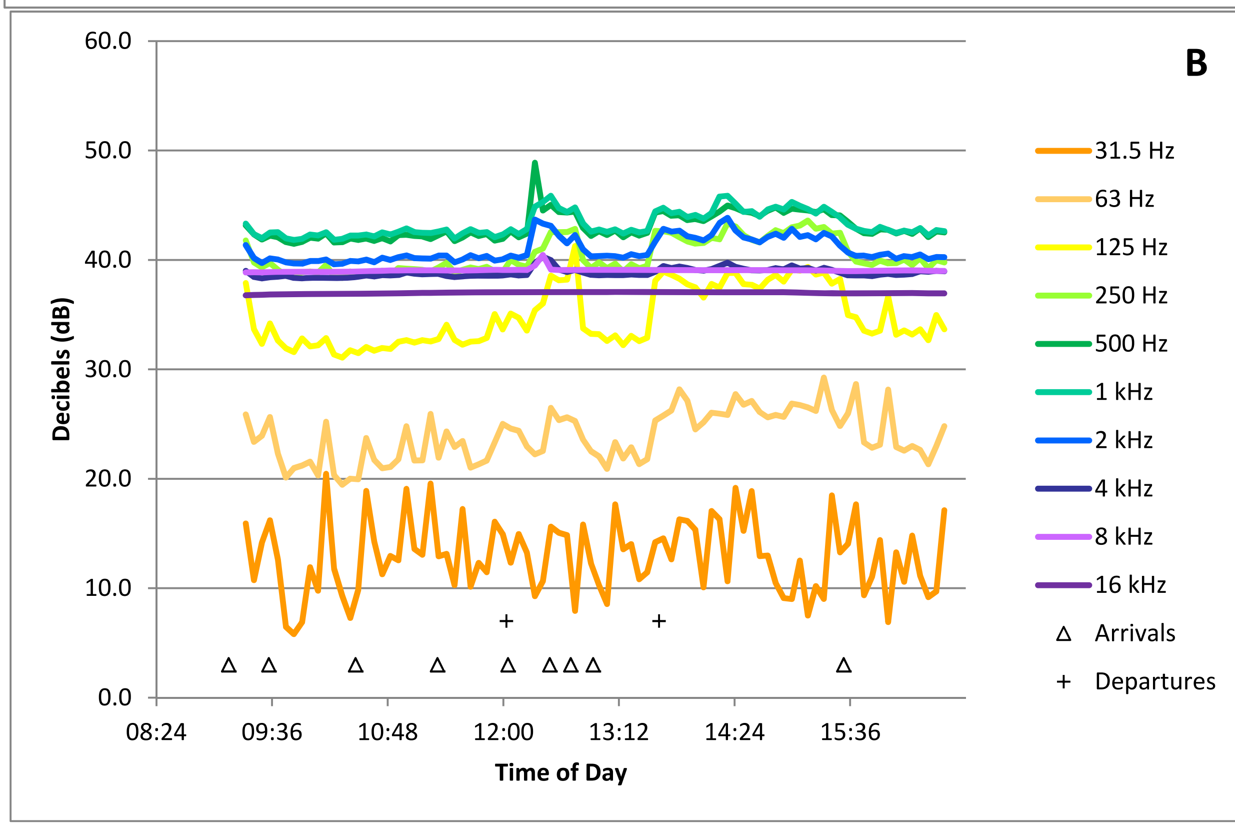


Figure A14. A-weighted Sound Levels (L_{Aeq}) for Octave Bands Integrated across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 22 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

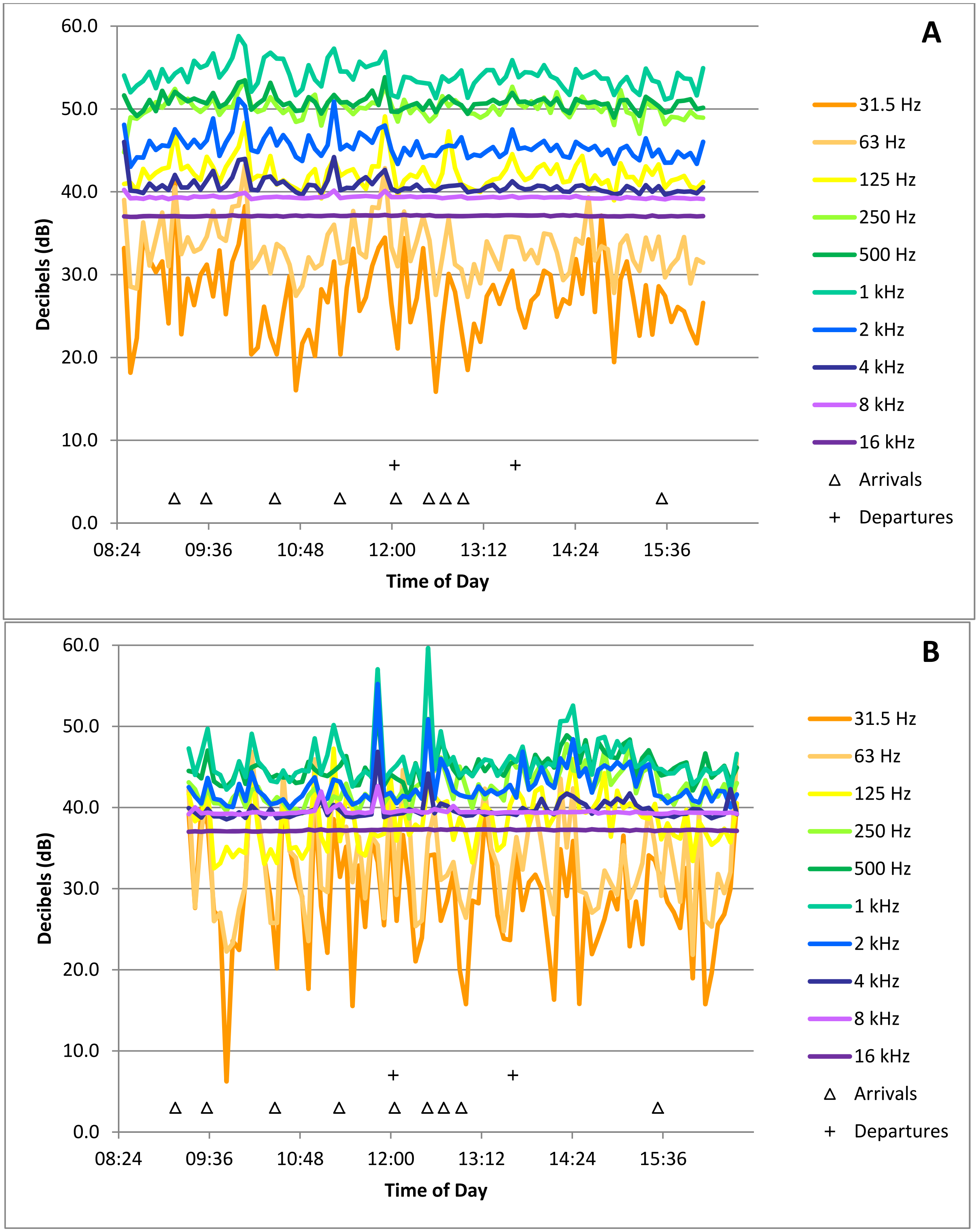


Figure A15. A-weighted Maximum Sound Levels (LAFmax) for Octave Bands Integrated across 5-minute Sample Periods at Cliff Edge (A) and Ritidian Pt #1 (B) on 17 April 2014

Arrivals (triangles) and departures (+) of aircraft at AAFB are shown at their time of occurrence.

Table A7. Summary dBA Values of Octave Bands for 22 April 2014

		Octave Band									
		31.5 Hz	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**
Ritidian Pt #1											
L_{Zeq}	min	5.80	19.45	31.07	38.36	41.48	41.83	39.60	38.31	38.85	36.76
	max	20.46	29.25	41.27	43.59	48.88	45.87	43.85	40.30	40.45	37.07
	L_{dcp}	14.14	24.49	35.68	40.67	43.22	43.39	41.09	38.85	39.05	36.98
L_{ZFmax}	min	6.24	21.85	32.52	38.65	40.95	42.16	39.94	38.54	39.12	37.00
	max	45.69	46.86	47.24	48.05	52.08	59.65	55.22	50.56	42.63	37.33
	L_{dcp}	33.78	37.63	39.54	42.88	45.50	47.42	43.74	40.44	39.53	37.20
Cliff Edge											
L_{Zeq}	min	13.02	25.32	38.10	47.30	48.18	50.16	42.90	39.30	38.88	36.78
	max	18.96	30.84	45.56	48.67	49.62	53.00	44.45	40.01	39.03	36.96
	L_{dcp}	15.50	27.25	39.24	48.07	48.80	51.41	43.66	39.65	38.96	36.88
L_{ZFmax}	min	15.86	27.32	38.97	44.77	48.96	51.14	43.02	39.62	39.09	36.96
	max	41.38	43.21	49.09	53.49	53.83	58.80	51.21	46.02	40.24	37.23
	L_{dcp}	29.93	34.62	42.69	50.35	50.90	54.35	45.85	40.79	39.35	37.09

Values are in dBA.

Discussion

The A-weighted SPL values of the data taken at NWF primarily serve to rescale ambient sound levels downward from unweighted levels and downplay the effects of transient changes in sound level, particularly when the majority of the sound energy is in the lower frequencies. What this SPL weighting transformation demonstrates is that hearing frequency weighting that corresponds to human hearing tends to reduce or eliminate frequencies in the natural environment where some of the greatest sources of sound occur. The results of the transformed data are most appropriately applied to humans. Other species do not hear with the same acuity at the same frequencies as humans. For examples, sea turtles are most sensitive to frequencies below 1 kHz (Ridgway et al. 1969, Bartol et al. 1999). Domestic pigs, on the other hand, have a range of hearing twice as high as humans (up to 40.5 kHz) with a region of best sensitivity from 250 Hz to 16 kHz (Heffner and Heffner 1990).

What is also interesting to note from the A-weighted transformation is that variation in SPL and the effect of the broadband sound elevations encountered in the data were reduced. It is questionable whether the few aircraft events that did appear correlated to broadband sound would be detectable or salient to human listeners in the field. In the case of humans, there seem to be few events in the data set that would appear to be a startling change in SPL.

Conclusion

The broadband A-weighted SPL values at NWF were mostly below 60 dBA on the days recorded for this study. The vast majority of L_{AFmax} values were also below 60 dBA, although some brief periods rose above 70 dBA, such as on 17 April (Figure A12B). The Cliff Edge site appears to generally have higher ambient sound levels than Ritidian Pt #1. This difference in ambient sound may be the reason some aircraft events are clearly observable in the SPL data at Ritidian Pt #1 and not at Cliff Edge. The environmental conditions for these recordings were mild, so it is possible that both sites would demonstrate greater levels of ambient sound if recorded when precipitation or wind levels were higher.

Literature Cited

Bartol, S.M., J.A. Musick, and M.L. Lenhardt. (1999). Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). *Copeia* 1999: 836-840.

Heffner, R.S. and H.E. Heffner. (1990). Hearing in domestic pigs (*Sus scrofa*) and goats (*Capra hircus*). *Hearing Research* 48: 231-240.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. (1969). Hearing in the giant sea turtle, *Chelonia mydas*. *Proceedings of the National Academy of Sciences of the United States of America* 64: 884-890.

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